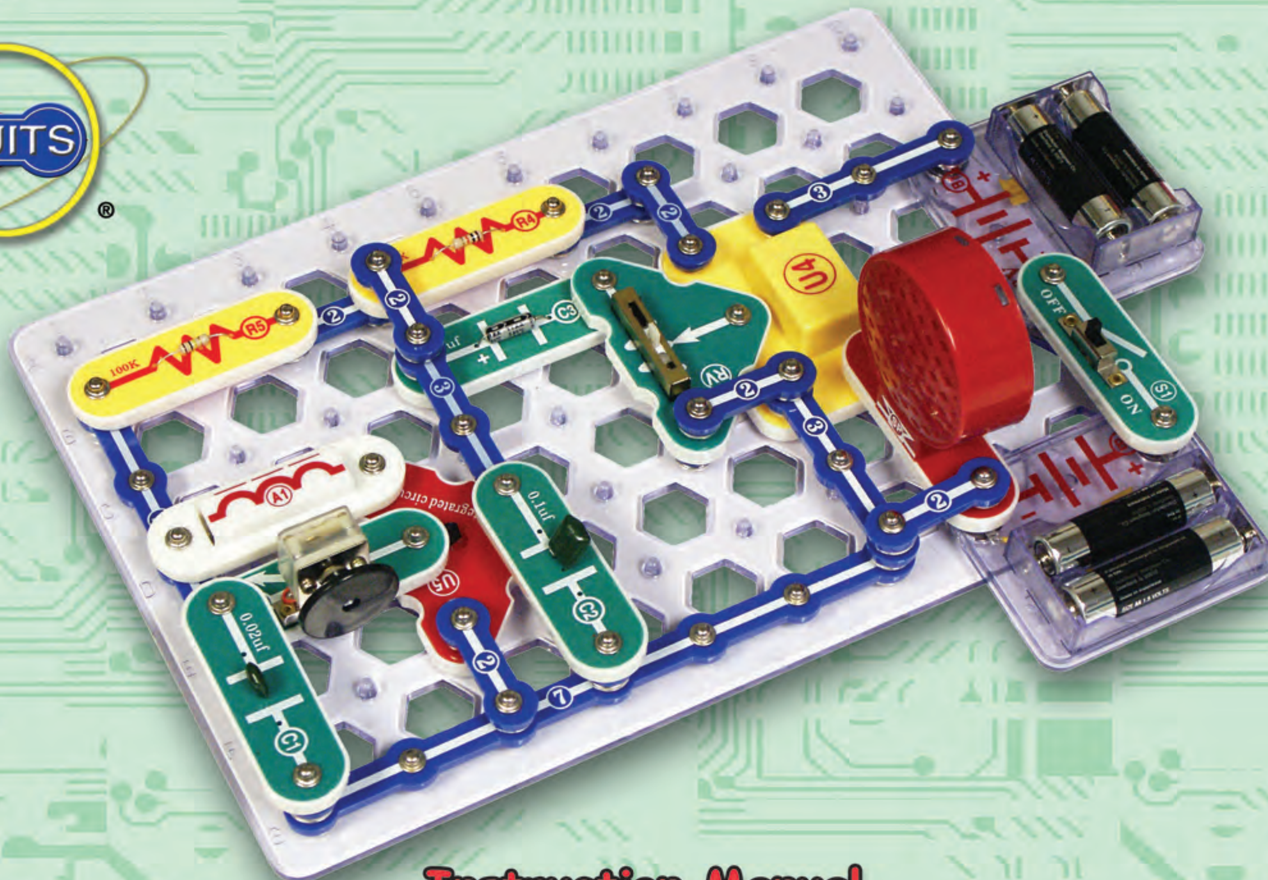
ELECTRONIC SNAP CIRCUITS®

Projects 102-305

SNAP CIRCUITS®

AGE 8 - 108



Project 242

Instruction Manual

ELENCO®

REV-H Revised 2012 753098
Patent #'s: 7,144,255, 7,273,377, & other patents pending

Table of Contents

Basic Troubleshooting

1. Most circuit problems are due to incorrect assembly. Always double-check that your circuit exactly matches the drawing for it.
2. Be sure that parts with positive/negative markings are positioned as per the drawing.
3. Be sure that all connections are securely snapped.
4. Try replacing the batteries.
5. If the motor spins but does not balance the fan, check the black plastic piece with three prongs on the motor shaft. Be sure that it is at the top of the shaft.

Elenco® is not responsible for parts damaged due to incorrect wiring.

Note: If you suspect you have damaged parts, you can follow the Advanced Troubleshooting procedure on page 5 to determine which ones need replacing.

WARNING: SHOCK HAZARD - Never connect Snap Circuits® to the electrical outlets in your home in any way!

WARNING: CHOKING HAZARD - Small parts. Not for children under 3 years.

WARNING FOR ALL PROJECTS WITH A ⚠ SYMBOL
Moving parts. Do not touch the motor or fan during operation. Do not lean over the motor. Do not launch the fan at people, animals, or objects. Eye protection is recommended.

Batteries:

- Use only 1.5V AA type, alkaline batteries (not included).
- Insert batteries with correct polarity.
- Non-rechargeable batteries should not be recharged. Rechargeable batteries should only be charged under adult supervision, and should not be recharged while in the product.
- Do not mix alkaline, standard (carbon-zinc), or rechargeable (nickel-cadmium) batteries.
- Do not mix old and new batteries.
- Remove batteries when they are used up.
- Do not short circuit the battery terminals.
- Never throw batteries in a fire or attempt to open its outer casing.
- Batteries are harmful if swallowed, so keep away from small children.
- Do not connect batteries or battery holders in parallel.

WARNING: Always check your wiring before turning on a circuit. Never leave a circuit unattended while the batteries are installed. Never connect additional batteries or any other power sources to your circuits. Discard any cracked or broken parts.

Adult Supervision: Because children's abilities vary so much, even with age groups, adults should exercise discretion as to which experiments are suitable and safe (the instructions should enable supervising adults to establish the experiment's suitability for the child). Make sure your child reads and follows all of the relevant instructions and safety procedures, and keeps them at hand for reference.

This product is intended for use by adults and children who have attained sufficient maturity to read and follow directions and warnings.

Never modify your parts, as doing so may disable important safety features in them, and could put your child at risk of injury.

Review of How To Use It (See page 3 of the Projects 1-101 manual for more details.)

The Snap Circuits® kit uses building blocks with snaps to build the different electrical and electronic circuits in the projects. These blocks are in different colors and have numbers on them so that you can easily identify them. The circuit you will build is shown in color and with numbers, identifying the blocks that you will use and snap together to form a circuit.

Next to each part in every circuit drawing is a small number in black. This tells you which level the component is placed at. Place all parts on level 1 first, then all of the parts on level 2, then all of the parts on level 3, etc.

A large clear plastic base grid is included with this kit to help keep the circuit block together. The base has rows labeled A-G and columns labeled 1-10.

Install two (2) "AA" batteries (not included) in the battery holder (B1). The 2.5V and 6V bulbs come packaged separate from their sockets. Install the 2.5V bulb in the L1 lamp socket, and the 6V bulb in the L2 lamp socket.

Place the fan on the motor (M1) whenever that part is used, unless the project you are building says not to use it.

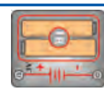
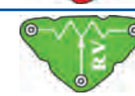
Some circuits use the red and black jumper wires to make unusual connections. Just clip them to the metal snaps or as indicated.

Note: While building the projects, be careful not to accidentally make a direct connection across the battery holder (a "short circuit"), as this may damage and/or quickly drain the batteries.

Parts List (Colors and styles may vary) Symbols and Numbers

Note: There are additional part lists in your other project manuals.

Important: If any parts are missing or damaged, **DO NOT RETURN TO RETAILER**. Call toll-free (800) 533-2441 or e-mail us at: help@elenco.com. Customer Service • 150 Carpenter Ave. • Wheeling, IL 60090 U.S.A.

Qty.	ID	Name	Symbol	Part #	Qty.	ID	Name	Symbol	Part #
❒ 3	①	1-Snap Wire		6SC01	❒ 1	(C3)	10μF Capacitor		6SCC3
❒ 3	②	2-Snap Wire		6SC02	❒ 1	(C4)	100μF Capacitor		6SCC4
❒ 1	③	3-Snap Wire		6SC03	❒ 1	(C5)	470μF Capacitor		6SCC5
❒ 1	④	4-Snap Wire		6SC04	❒ 1	(R2)	1kΩ Resistor		6SCR2
❒ 1	⑦	7-Snap Wire		6SC07	❒ 1	(R3)	5.1kΩ Resistor		6SCR3
❒ 1	(B1)	Battery Holder - uses 2 1.5V type AA (not Included)		6SCB1	❒ 1	(R4)	10kΩ Resistor		6SCR4
❒ 1	(A1)	Antenna Coil		6SCA1	❒ 1	(R5)	100kΩ Resistor		6SCR5
❒ 1	(D2)	Green Light Emitting Diode (LED)		6SCD2	❒ 1	(U5)	High Frequency Integrated Circuit		6SCU5
❒ 1	(L2)	6V Lamp		6SCL2	❒ 1	(Q1)	PNP Transistor		6SCQ1
❒ 1	(X1)	Microphone		6SCX1	❒ 1	(Q2)	NPN Transistor		6SCQ2
❒ 1	(U4)	Power Amplifier Integrated Circuit		6SCU4	❒ 1	(RV)	Adjustable Resistor		6SCRV
❒ 1	(C1)	0.02μF Capacitor		6SCC1	❒ 1	(CV)	Variable Capacitor		6SCCV
❒ 1	(C2)	0.1μF Capacitor		6SCC2	**You may order additional / replacement parts at our website: www.snapcircuits.net**				

MORE About Your Snap Circuits® Parts

Our Student Guides give much more information about your parts along with a complete lesson in basic electronics. See www.snapcircuits.net/learn.htm or page 74 for more information.

(Part designs are subject to change without notice).

Note: There is additional information in your other project manual.

The green **LED (D2)** works the same as the red LED (D1) and the **6V lamp (L2)** works the same as the 2.5V lamp; these are described in the projects 1-101 manual.

Resistors "resist" the flow of electricity and are used to control or limit the electricity in a circuit. Snap Circuits® includes **100Ω (R1), 1KΩ (R2), 5.1KΩ (R3), 10KΩ (R4), and 100KΩ (R5) resistors** ("K" symbolizes 1,000, so R3 is really 5,100Ω). Materials like metal have very low resistance (<1Ω) and are called conductors, while materials like paper, plastic, and air have near-infinite resistance and are called insulators.

The **adjustable resistor (RV)** is a 50KΩ resistor but with a center tap that can be adjusted between 0Ω and 50KΩ. At the 0Ω setting, the current must be limited by the other components in the circuit.

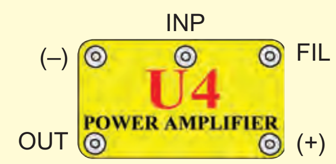
The **microphone (X1)** is actually a resistor that changes in value when changes in air pressure (sounds) apply pressure to its surface. Its resistance typically varies from around 1KΩ in silence to around 10KΩ when you blow on it.

Capacitors are components that can store electrical pressure (voltage) for periods of time, higher values have more storage. Because of this storage ability they block unchanging voltage signals and pass fast changing voltages. Capacitors are used for filtering and oscillation circuits. Snap Circuits® includes **0.02μF (C1), 0.1μF (C2), 10μF (C3), 10μF (C4), 470μF (C5) capacitors, and a variable capacitor (CV).** The variable capacitor can be adjusted from .00004 to .00022μF and is used in high frequency radio circuits for tuning. The whistle chip (WC) also acts like a 0.02μF capacitor in addition to its sound properties.

The **antenna (A1)** contains a coil of wire wrapped around an iron bar. Although it has magnetic effects similar to those in the motor, those effects are tiny and may be ignored except at high frequencies (like in AM radio). Its magnetic properties allow it to concentrate radio signals for reception. At lower frequencies the antenna acts like an ordinary wire.

The **PNP (Q1) and NPN (Q2) transistors** are components that use a small electric current to control a large current, and are used in switching, amplifier, and buffering applications. They are easy to miniaturize, and are the main building blocks of integrated circuits including the microprocessor and memory circuits in computers. Projects #124-125 and #128-133 demonstrate their properties. A high current may damage a transistor, so the current must be limited by other components in the circuit.

The **power amplifier IC (U4)** is a module containing an integrated circuit amplifier and supporting components that are always needed with it. A description of it is given here for those interested:

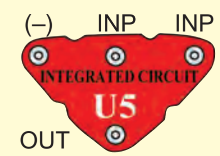


Power Amplifier IC:

(+) - power from batteries
(–) - power return to batteries
FIL - filtered power from batteries
INP - input connection
OUT - output connection

See project #242 for example of connections.

The **high frequency IC (U5)** is a specialized amplifier used only in high frequency radio circuits. A description of it is given here for those interested:



High Frequency IC:

INP - input connection (2 points are same)
OUT - output connection
(–) power return to batteries

See project #242 for example of connections.

DO’s and DON’Ts of Building Circuits

After building the circuits given in this booklet, you may wish to experiment on your own. Use the projects in this booklet as a guide, as many important design concepts are introduced throughout them. Every circuit will include a power source (the batteries), a resistance (which might be a resistor, lamp, motor, integrated circuit, etc.), and wiring paths between them and back. You must be careful not to create "short circuits" (very low-resistance paths across the batteries, see examples below) as this will damage components and/or quickly drain your batteries. Only connect the ICs using configurations given in the projects, incorrectly doing so may damage them. **Elenco® is not responsible for parts damaged due to incorrect wiring.**

Here are some important guidelines:

- ***ALWAYS*** **USE EYE PROTECTION WHEN EXPERIMENTING ON YOUR OWN.**
- ***ALWAYS*** include at least one component that will limit the current through a circuit, such as the speaker, lamp, whistle chip, capacitors, ICs (which must be connected properly), motor, microphone, photoresistor, or resistors (the adjustable resistor doesn’t count if it’s set at/near minimum resistance).
- ***ALWAYS*** use LEDs, transistors, the high frequency IC, the antenna, and switches in conjunction with other components that will limit the current through them. Failure to do so will create a short circuit and/or damage those parts.
- ***ALWAYS*** connect the adjustable resistor so that if set to its 0 setting, the current will be limited by other components in the circuit.
- ***ALWAYS*** connect position capacitors so that the “+” side gets the higher voltage.
- ***ALWAYS*** disconnect your batteries immediately and check your wiring if something appears to be getting hot.
- ***ALWAYS*** check your wiring before turning on a circuit.
- ***ALWAYS*** connect ICs using configurations given in the projects or as per the connection descriptions for the parts.
- ***NEVER*** try to use the high frequency IC as a transistor (the packages are similar, but the parts are different).
- ***NEVER*** use the 2.5V lamp in a circuit with both battery holders unless you are sure that the voltage across it will be limited.
- ***NEVER*** connect to an electrical outlet in your home in any way.
- ***NEVER*** leave a circuit unattended when it is turned on.
- ***NEVER*** touch the motor when it is spinning at high speed.

Note: If you have the more advanced Models SC-500 or SC-750, there are additional guidelines in your other project manual(s).

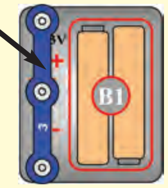
For all of the projects given in this book, the parts may be arranged in different ways without changing the circuit. For example, the order of parts connected in series or in parallel does not matter — what matters is how combinations of these sub-circuits are arranged together.

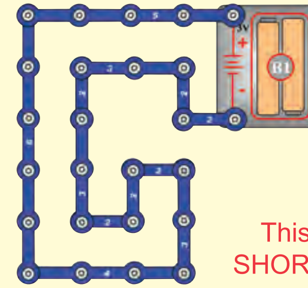
Warning to Snap Rover owners: Do not connect your parts to the Rover body except when using our approved circuits, the Rover body has a higher voltage which could damage your parts.

Examples of SHORT CIRCUITS - NEVER DO THESE!!!

Placing a 3-snap wire directly across the batteries is a SHORT CIRCUIT.

NEVER DO!



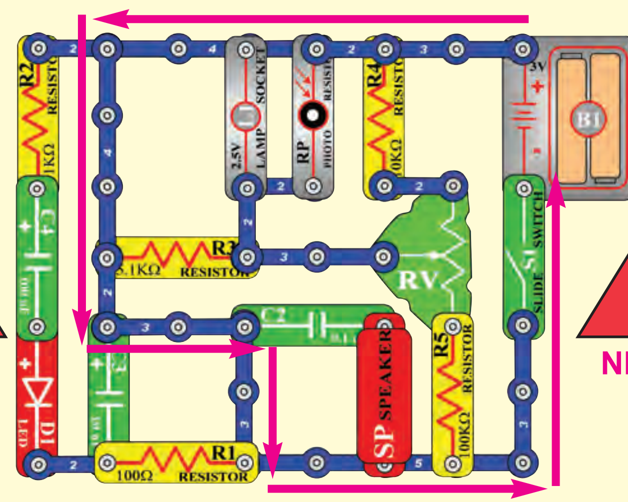


NEVER DO!

This is also a SHORT CIRCUIT.

When the slide switch (S1) is turned on, this large circuit has a SHORT CIRCUIT path (as shown by the arrows). The short circuit prevents any other portions of the circuit from ever working.

NEVER DO!



NEVER DO!

You are encouraged to tell us about new circuits you create. If they are unique, we will post them with your name and state on our website at **www.snapcircuits.net/kidkreations.htm**. Send your suggestions to Elenco®.

Elenco® provides a circuit designer so that you can make your own Snap Circuits® drawings. This Microsoft® Word document can be downloaded from **www.snapcircuits.net/SnapDesigner.doc** or through the **www.snapcircuits.net** website.

WARNING: SHOCK HAZARD - Never connect Snap Circuits® to the electrical outlets in your home in any way!

MORE Advanced Troubleshooting (Adult supervision recommended)

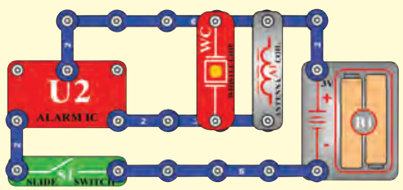
Elenco® is not responsible for parts damaged due to incorrect wiring.

If you suspect you have damaged parts, you can follow this procedure to systematically determine which ones need replacing:

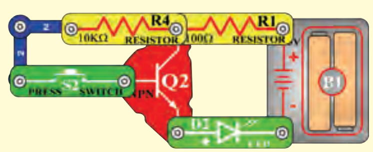
1. - 9. Refer to project manual 1 (projects 1-101) for testing steps 1-9, then continue below. Test both lamps (L1, L2) and battery holders in test step 1, all blue snap wires in step 3, and both LEDs (D1, D2) in step 5.

10. **1KΩ (R2), 5.1KΩ (R3), and 10KΩ (R4) resistors:** Build project #7 but use each of these resistors in place of the 100Ω resistor (R1), the LED should light and the brightness decreases with the higher value resistors.

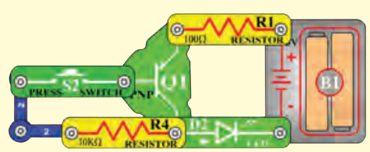
11. **Antenna (A1):** Build the mini-circuit shown here, you should hear sound.



12. **NPN transistor (Q2):** Build the mini-circuit shown here. The LED (D2) should only be on if the press switch (S2) is pressed. If otherwise, then the NPN is damaged.



13. **PNP transistor (Q1):** Build the mini-circuit shown here. The LED (D1) should only be on if the press switch (S2) is pressed. If otherwise, then the PNP is damaged.



14. **Adjustable resistor (RV):** Build project #261 but use the 100Ω resistor (R1) in place of the photoresistor (RP), the resistor control can turn the LED (D1) on and off.

15. **100ΩK resistor (R5) and 0.02µF (C1), 0.1µF (C2), and 10µF (C3) capacitors:** Build project #206, it makes sound unless the resistor is bad. Place the 0.02µF capacitor on top of the whistle chip (WC) and the sound changes (pitch is lower). Replace the 0.02µF with the 0.1µF and the pitch is even lower. Replace the 0.1µF with the 10µF and the circuit will "click" about once a second.

16. **100µF (C4) and 470µF (C5) capacitors:** Build project #225, press the press switch (S2) and turn on the slide switch (S1). The LED (D1) should be lit for about 15 seconds then go out (press the press switch again to reset this). Replace the 470µF with the 100µF and the LED is only lit for about 4 seconds now.

17. **Power Amplifier IC (U4):** Build project #293, the sound from the speaker (SP) should be loud.

18. **Microphone (X1):** Build project #109, blowing into the microphone should turn off the lamp (L2).

19. **Variable Capacitor (CV):** Build project #213 and place it near an AM radio, tune the radio and the capacitor to verify you hear the music on your radio.

20. **High Frequency IC (U5):** Build project #242 and adjust the variable capacitor (CV) and adjustable resistor (RV) until you hear a radio station.

Note: If you have the more advanced Models SC-500 or SC-750, there are additional tests in your other project manuals.

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Web site: www.elenco.com

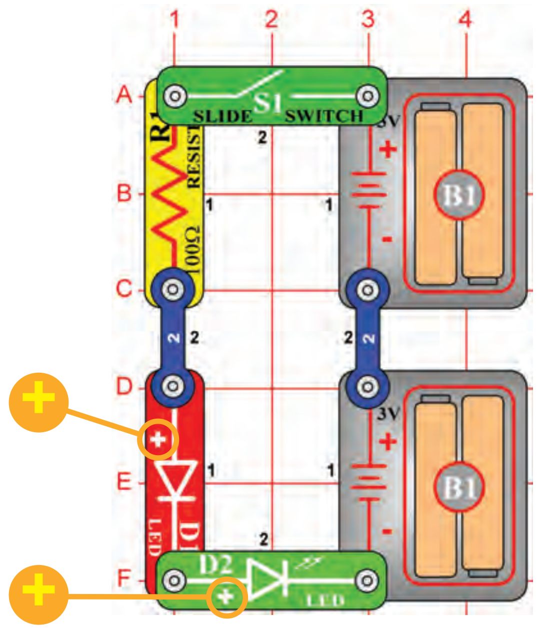
You may order additional / replacement parts at: www.snapcircuits.net

Project Listings

Project Listings

Project #102 — Batteries in Series

OBJECTIVE: To show the increase in voltage when batteries are connected in series.

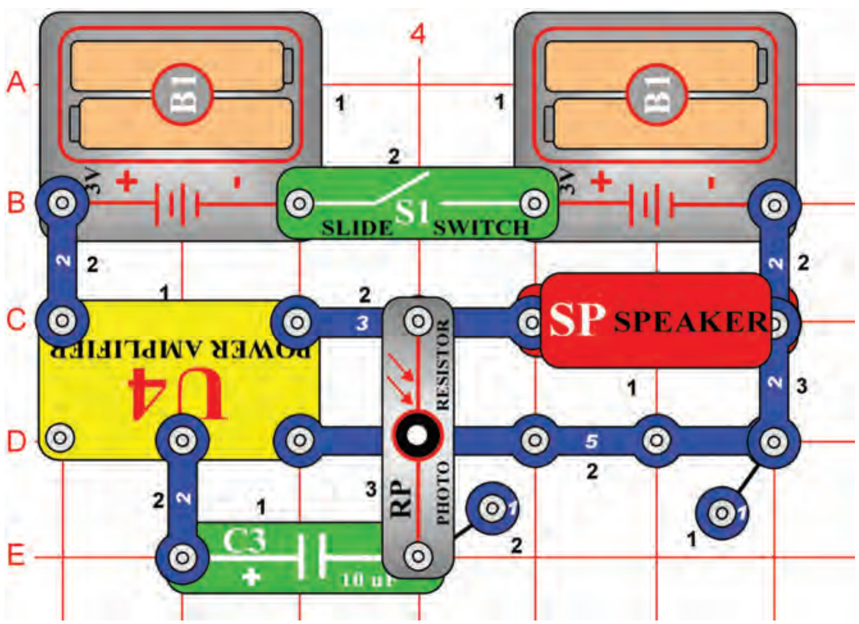


When you turn on the slide switch (S1), current flows from the batteries through the slide switch, the 100Ω resistor (R1), the LED (D1), through the LED (D2), and back to the second group of batteries (B1). Notice how both LED's are lit. The voltage is high enough to turn on both LED's when the batteries are connected in series. If only one set of batteries is used, the LED's will not light up.

Some devices use only one 1.5 volt battery, but they make hundreds of volts electronically from this small source. A flash camera is an example of this.

Project #103 — Ticking Screecher

OBJECTIVE: To make fun sounds using light.



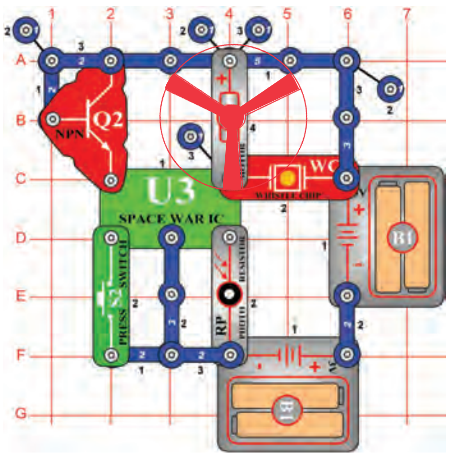
Build the circuit as shown, and turn on the slide switch (S1). Vary the amount of light to the photoresistor (RP) by partially covering it with your hand. You can make screeching sounds by allowing just a little light to reach the photoresistor.

If you replace the 10μF capacitor (C3) with a 3-snap wire or any of the other capacitors (C1, C2, C4, or C5), then the sound will be a little different.

Project #104

Spacey Fan

OBJECTIVE: To build a fan with sound that is activated by light.



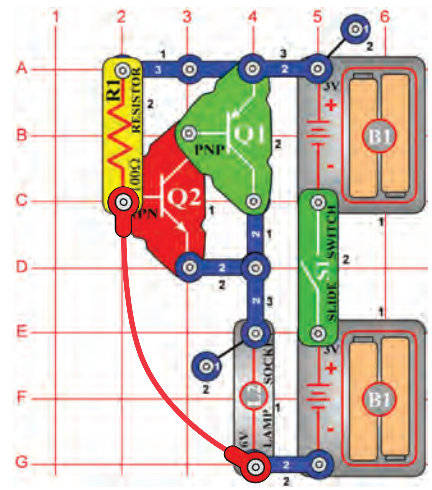
Place the fan onto the motor (M1). Sounds are heard if light shines on the photoresistor (RP) OR if you press the press switch (S2), the fan may start to spin, but will only get to high speed if you do BOTH. Try various combinations of shining light and holding down the press switch.

WARNING: Moving parts. Do not touch the fan or motor during operation. Do not lean over the motor.

Project #105

Two-Transistor Light Alarm

OBJECTIVE: To compare transistor circuits.

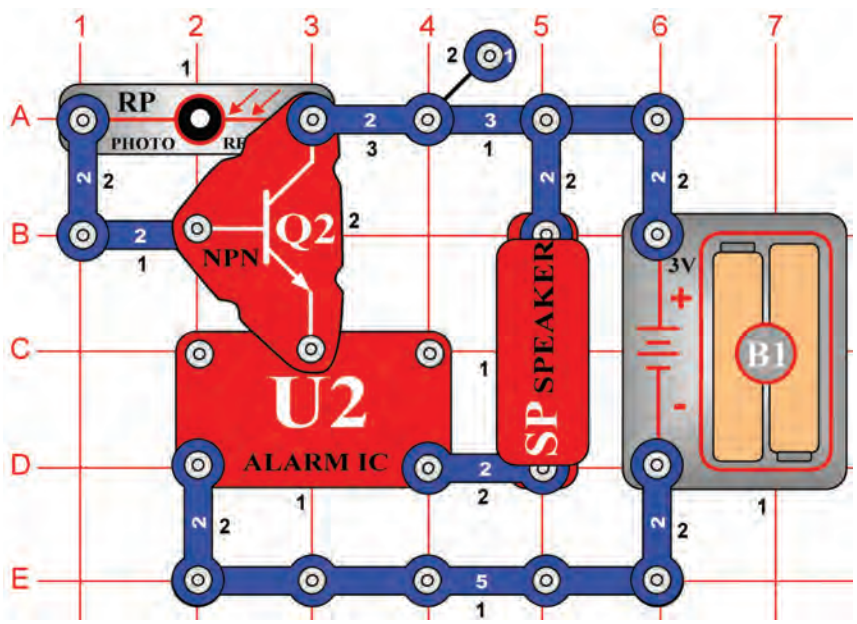


This light alarm circuit uses two transistors (Q1 & Q2) and both sets of batteries. Build the circuit with the jumper connected as shown, and turn it on. Nothing happens. Break the jumper connection and the lamp (L2) turns on. You could replace the jumper with a longer wire and run it across a doorway to signal an alarm when someone enters.

Project #106

Light-controlled Alarm

OBJECTIVE: To show how light is used to turn an alarm.



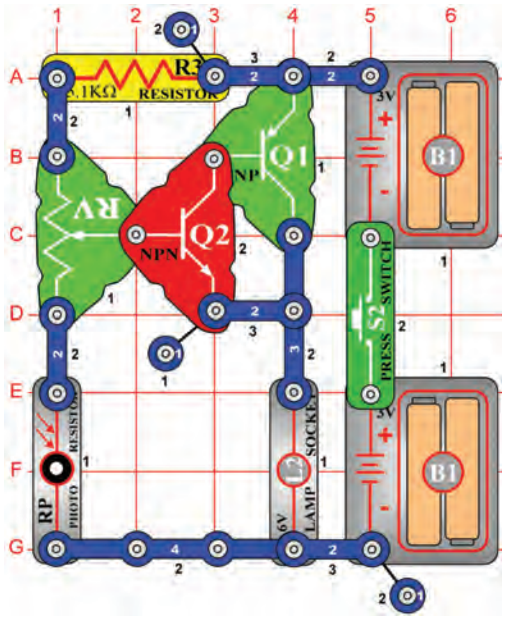
The alarm will sound, as long as light is present. Slowly cover the photoresistor (RP), and the volume goes down. If you turn off the lights, the alarm will stop. The amount of light changes the resistance of the photoresistor (less light means more resistance). The photoresistor and transistor (Q2) act like a dimmer switch, adjusting the voltage applied to the alarm.

This type of circuit is used in alarm systems to detect light. If an intruder turned on a light or hit the sensor with a flashlight beam, the alarm would trigger and probably force the intruder to leave.

Project #107

Automatic Street Lamp

OBJECTIVE: To show how light is used to control a street lamp.



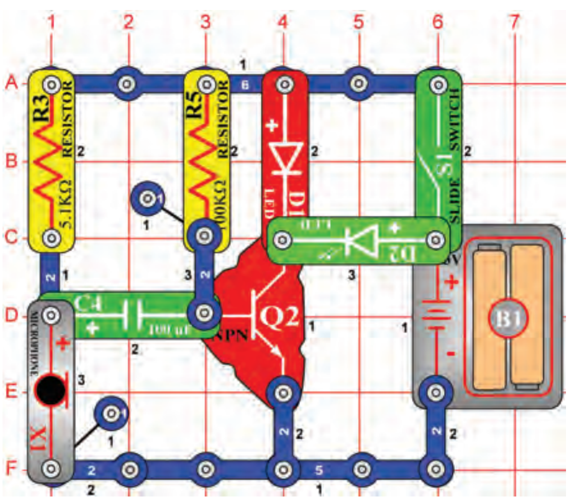
Press the press switch (S2) on and set the adjustable resistor (RV) so the lamp (L2) just lights. Slowly cover the photoresistor (RP) and the lamp brightens. If you place more light at the photoresistor the light dims.

This is an automatic street lamp that you can turn on by a certain darkness and turn off by a certain brightness. This type of circuit is installed on many outside lights and forces them to turn off and save electricity. They also come on when needed for safety.

Project #108

Voice-controlled Rays of Light

OBJECTIVE: To show how light is stimulated by sound.

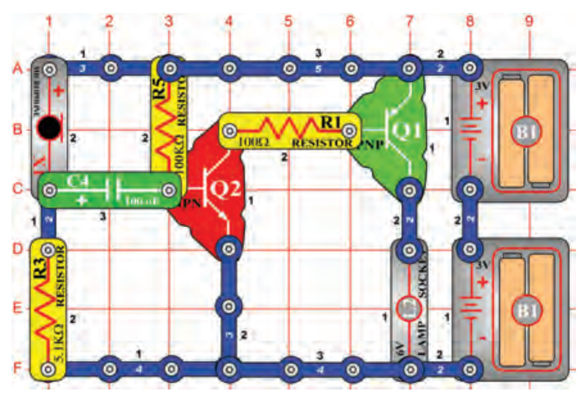


Turn the slide switch (S1) on. There will be only a weak light emitting from the green LED (D2). By blowing on the mic (X1) or putting it near a radio or TV set, the green LED will emit light, and its brightness changes as the loudness changes.

Project #109

Blowing Off the Electric Light

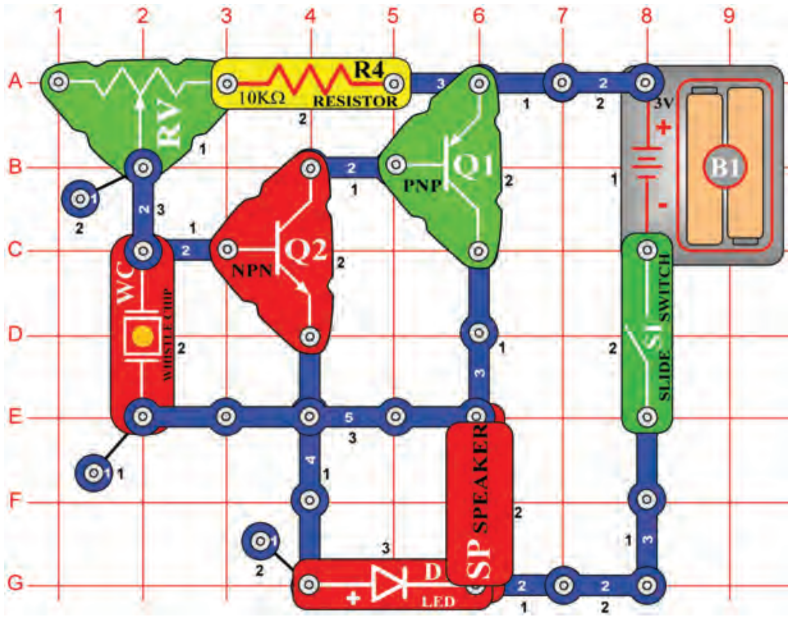
OBJECTIVE: To show how light is stimulated by sound.



Install the parts. The lamp (L2) will be on. It will be off as long as you blow on the mic (X1). Speaking loud into the mic will change the brightness of the lamp.

Project #110

Adjustable Tone Generator



OBJECTIVE: To show how resistor values change the frequency of an oscillator.

Turn on the slide switch (S1); the speaker (SP) will sound and the LED (D1) will light. Adjust the adjustable resistor (RV) to make different tones. In an oscillator circuit, changing the values of resistors or capacitors can vary the output tone or pitch.

Project #111

Photosensitive Electronic Organ

OBJECTIVE: To show how resistor values change the frequency of an oscillator.

Use the circuit from project #110 shown above. Replace the 10kΩ resistor (R4) with the photoresistor (RP). Turn on the slide switch (S1). The speaker (SP) will sound and the LED (D1) will light. Move your hand up and down over the photoresistor and the frequency changes. Decreasing the light on the photoresistor increases the resistance and causes the circuit to oscillate at a lower frequency. Notice that the LED flashes also at the same frequency as the sound.

By using your finger, see if you can vary the sounds enough to make this circuit sound like an organ playing.

Project #112

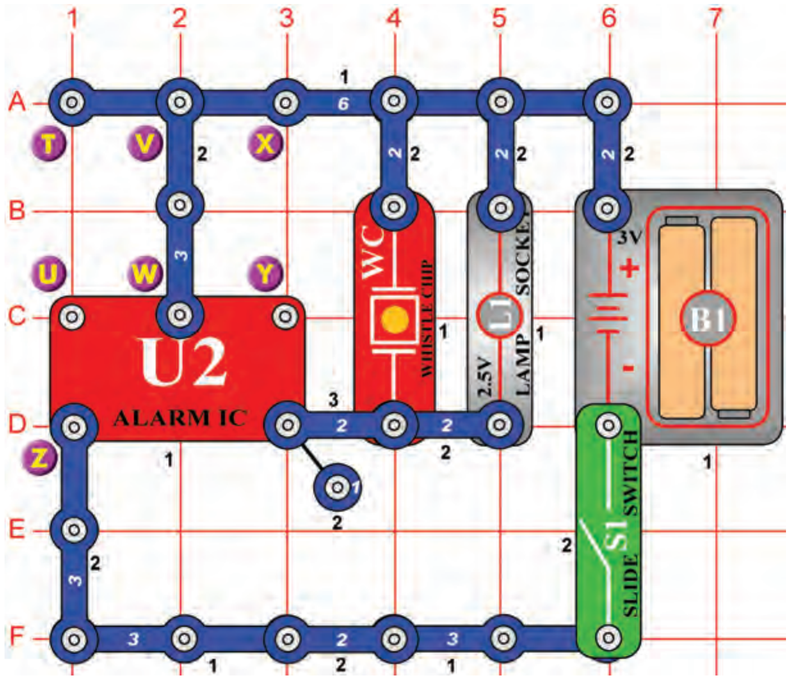
Electronic Cicada

OBJECTIVE: To show how capacitors in parallel change the frequency of an oscillator.

Use the circuit from project #110 shown above, replace the photoresistor (RP) back to the 10kΩ resistor (R4). Place the 0.02μF capacitor (C1) on top of the whistle chip (WC). Place the slide switch (S1) on and adjust the adjustable resistor (RV). The circuit produces the sound of the cicada insect. By placing the 0.02μF capacitor on top of the whistle chip, the circuit oscillates at a lower frequency. Notice that the LED (D1) flashes also at the same frequency.

It is possible to pick resistors and capacitors that will make the pitch higher than humans can hear. Many animals, however, can hear these tones. For example, a parakeet can hear tones up to 50,000 cycles per second, but a human can only hear to 20,000.

Project #113 Light & Sounds



OBJECTIVE: To build a police siren with light.

Turn on the slide switch (S1). A police siren is heard and the lamp (L1) lights.

Project #114 More Light & Sounds

OBJECTIVE: To show a variation of the circuit in project #113.

Modify the last circuit by connecting points X & Y. The circuit works the same way but now it sounds like a machine gun.

Project #115 More Light & Sounds (II)

OBJECTIVE: To show a variation of the circuit in project #113.

Now remove the connection between X & Y and then make a connection between T & U. Now it sounds like a fire engine.

Project #116 More Light & Sounds (III)

OBJECTIVE: To show a variation of the circuit in project #113.

Now remove the connection between T & U and then make a connection between U & Z. Now it sounds like an ambulance.

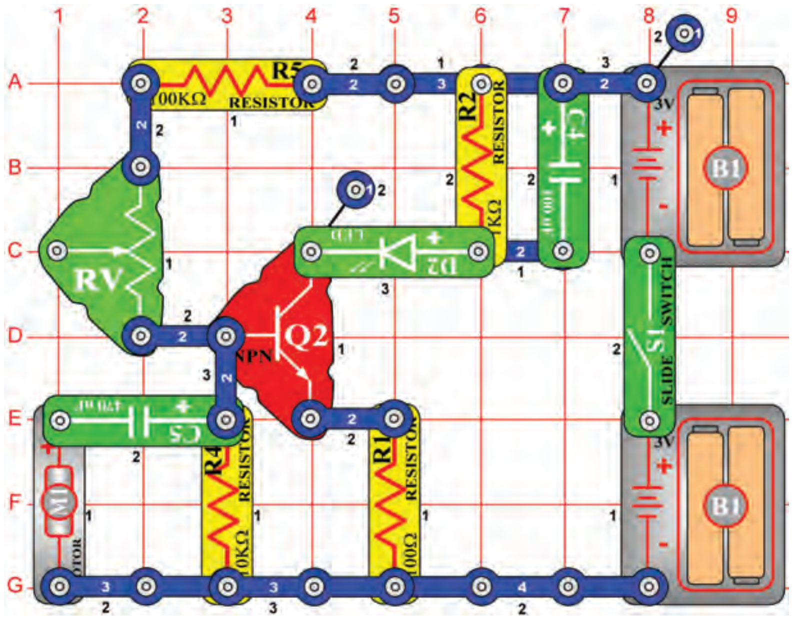
Project #117 More Light & Sounds (IV)

OBJECTIVE: To show a variation of the circuit in project #113.

Now remove the connection between U & Z, then place the 470μF capacitor (C5) between T & U ("+" side to T). The sound changes after a few seconds.

☐ Project #118 Motor Speed Detector

OBJECTIVE: To show how to make electricity in one direction.

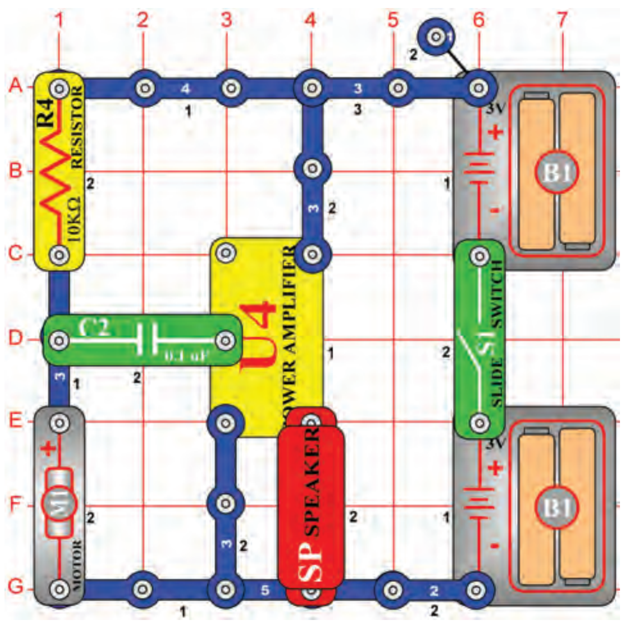


When building the circuit, be sure to position the motor (M1) with the positive (+) side snapped to the 470μF capacitor (C5). Turn on the slide switch (S1), nothing will happen. It is a motor speed detector, and the motor isn't moving. Watch the LED (D2) and give the motor a good spin CLOCKWISE with your fingers (don't use the fan blade); you should see a flash of light. The faster you spin the motor, the brighter the flash will be. As a game, see who can make the brightest flash.

Now try spinning the motor in the opposite direction (counter-clockwise) and see how bright the flash is — it won't flash at all because the electricity it produces, flows in the wrong direction and won't activate the diode. Flip the motor around (positive (+) side snapped to the 3-snap wire) and try again. Now the LED lights only if you spin the motor counter-clockwise.

☐ Project #119 Old-Style Typewriter

OBJECTIVE: To show how a generator works.



Turn on the slide switch (S1), nothing will happen. Turn the motor (M1) slowly with your fingers (don't use the fan blade), you will hear a clicking that sounds like an old-time manual typewriter keystrokes. Spin the motor faster and the clicking speeds up accordingly.

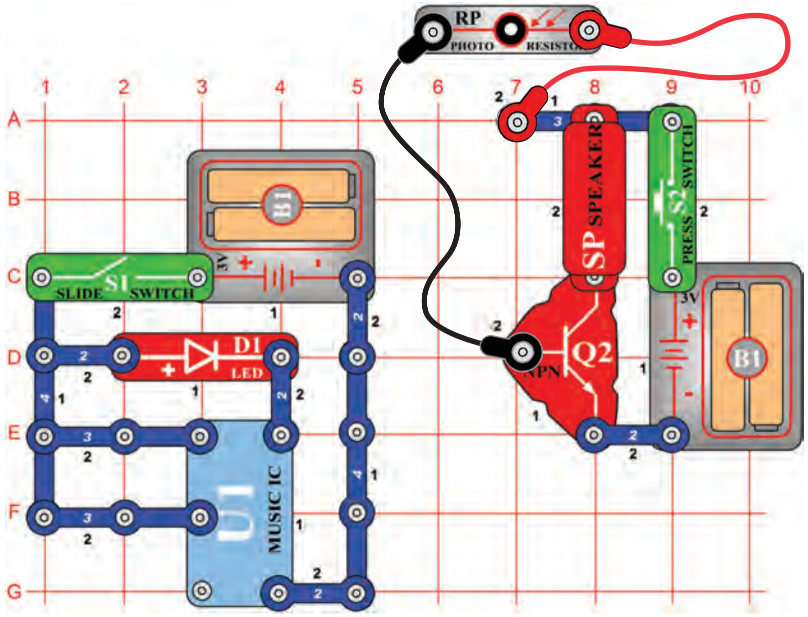
This circuit works the same if you spin the motor in either direction (unlike the Motor Speed Detector project).

By spinning the motor with your fingers, the physical effort you exert is converted into electricity. In electric power plants, steam is used to spin large motors like this, and the electricity produced is used to run everything in your town.

☐ Project #120

Optical Transmitter & Receiver

OBJECTIVE: To show how information can be transmitted using light.



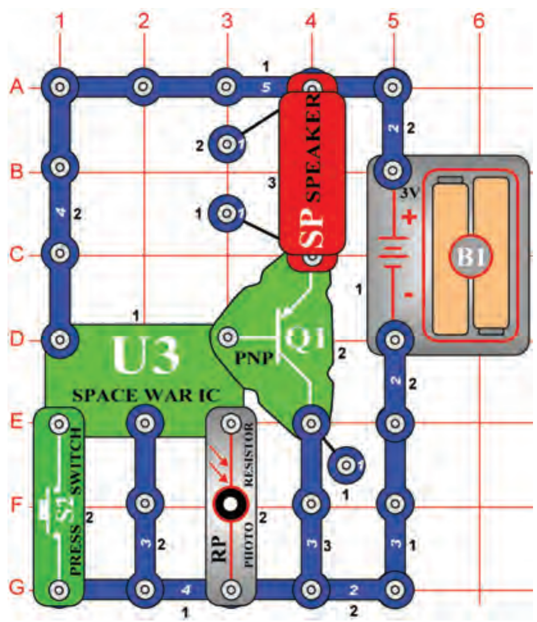
Build the circuit shown. Connect the photoresistor (RP) to the circuit using the red & black jumper wires. Place the photoresistor upside down over the red LED (D1), so the LED goes inside the photoresistor. Turn on both switches (hold down the press switch button). Music plays on the speaker, even though the two parts of the circuit are not electrically connected.

The left circuit, with the LED and music IC (U1) creates a music signal and transmits it as light. The right circuit, with the photoresistor and speaker, receives the light signal and converts it back to music. Here the photoresistor has to be on top of the LED for this to work, but better communication systems (such as fiber optic cables), can transmit information over enormous distances at very high speeds.

☐ Project #121

Space War Sounds Controlled By Light

OBJECTIVE: To change the sounds of a multiple space war with light.

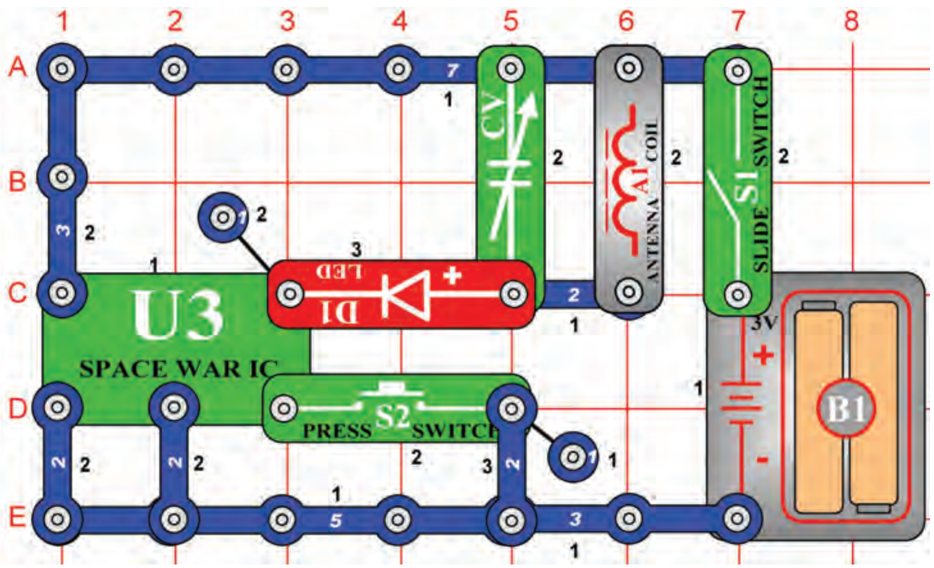


The space war IC (U3) will play a sound continuously. Block the light to the photoresistor (RP) with your hand. The sound will stop. Remove your hand and a different sound is played. Wave your hand over the photoresistor to hear all the different sounds.

Press the press switch down and now two space war sounds are played. If you hold the press switch down the sound repeats. Press the press switch again and a different sound is played. Keep pressing the press switch to hear all the different combinations of sounds.

☐ Project #122 — Space War Radio

OBJECTIVE: To transmit Space War sounds to a AM radio.

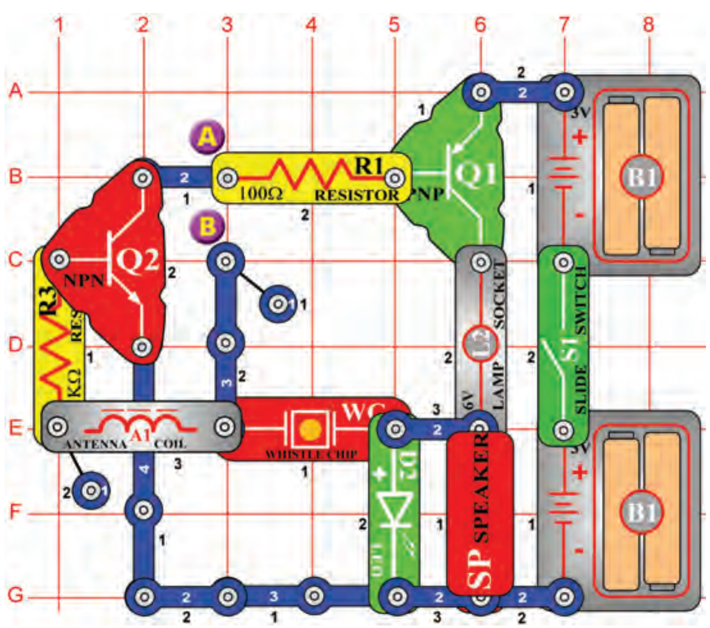


Place the circuit next to an AM radio. Tune the radio so no stations are heard and turn on the slide switch (S1). You should hear the space war sounds on the radio. The red LED (D1) should also be lit. Adjust the variable capacitor (CV) for the loudest signal. Push the press switch (S2) to change the sound.

You have just performed the experiment that took Marconi (who invented the radio) a lifetime to invent. The technology of radio transmission has expanded to the point that we take it for granted. There was a time, however, when news was only spread by word of mouth.

☐ Project #123 — The Lie Detector

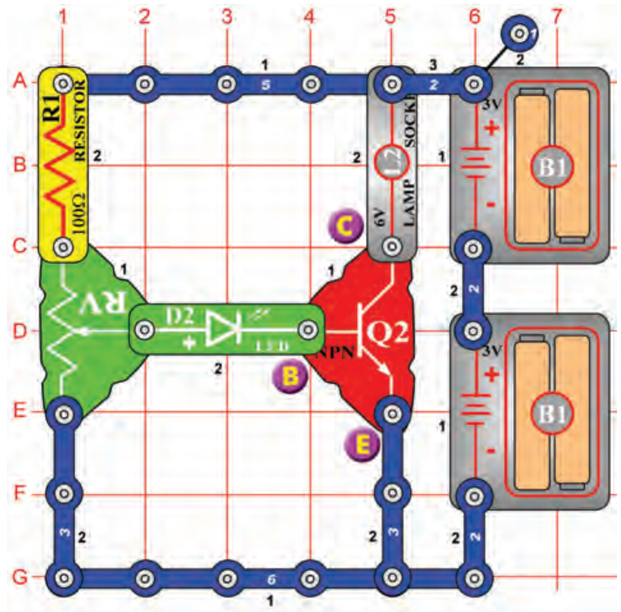
OBJECTIVE: To show how sweat makes a better conductor.



Turn on the slide switch (S1) and place your finger across points A & B. The speaker (SP) will output a tone and the LED (D2) will flash at the same frequency. Your finger acts as a conductor connecting points A & B. When a person is lying, one thing the body starts to do is sweat. The sweat makes the finger a better conductor by reducing its resistance.

As the resistance drops, the frequency of the tone increases. Lightly wet your finger and place it across the two points again. Both the output tone and LED flashing frequency increase, and the lamp (L2) may begin to light. If your finger is wet enough, then the lamp will be bright and the sound stops - indicating you are a big liar! Now change the wetness of your finger by drying it and see how it affects the circuit. This is the same principle used in lie detectors that are sold commercially.

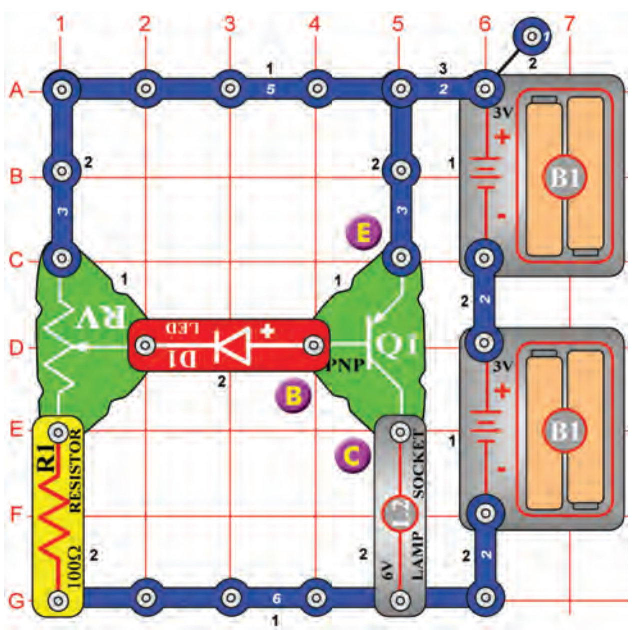
☐ # Project #124 NPN Amplifier



OBJECTIVE: To compare transistor circuits.

There are three connection points on an NPN transistor (Q2), called base (marked B), emitter (marked E), and collector (marked C). When a small electric current flows from the base to the emitter, a larger (*amplified*) current will flow from the collector to the emitter. Build the circuit and slowly move up the adjustable resistor (RV) control. When the LED (D2) becomes bright, the lamp (L2) will also turn on and will be much brighter.

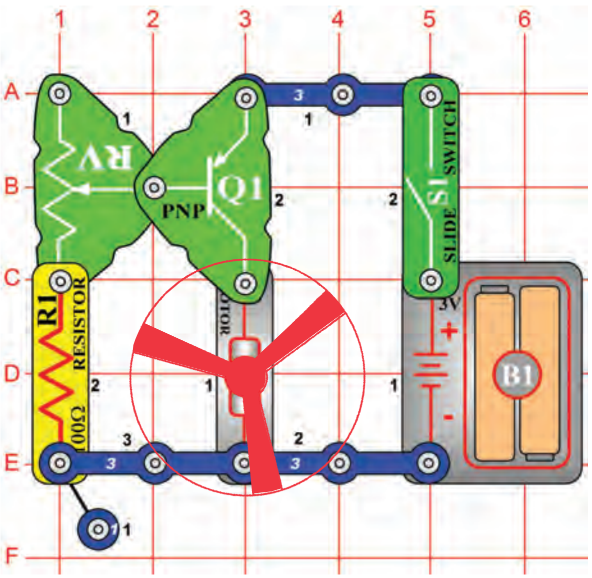
☐ # Project #125 PNP Amplifier



OBJECTIVE: To compare transistor circuits.

The PNP transistor (Q1) is similar to the NPN transistor (Q2) in project #166, except that the electric currents flow in the opposite directions. When a small electric current flows from the emitter to the base, a larger (*amplified*) current will flow from the emitter to the collector. Build the circuit and slowly move up the adjustable resistor (RV) control. When the LED (D1) becomes bright, the lamp (L2) will also turn on and will be much brighter.

☐ Project #126 Sucking Fan



OBJECTIVE: To adjust the speed of a fan.

Build the circuit, and be sure to orient the motor (M1) with the positive (+) side down as shown. Turn it on, and set the adjustable resistor (RV) for the fan speed you like best. If you set the speed too fast then the fan may fly off the motor. Due to the shape of the fan blades and the direction the motor spins, air is sucked into the fan and towards the motor. Try holding a piece of paper just above the fan to prove this. If this suction is strong enough then it can lift the fan blades, just like in a helicopter.

The fan will not move on most settings of the resistor, because the resistance is too high to overcome friction in the motor. If the fan does not move at any resistor setting, then replace your batteries.

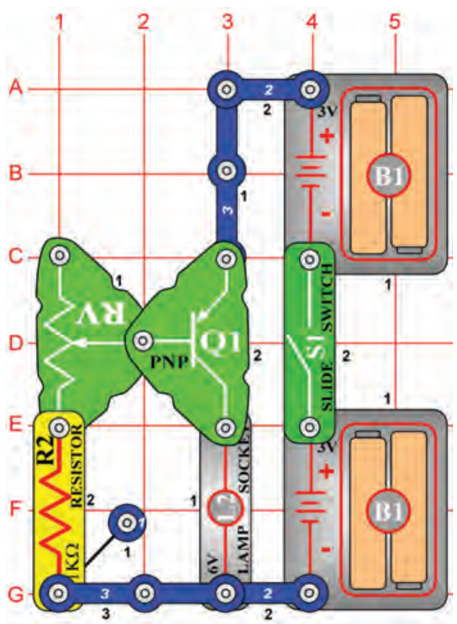
WARNING: Moving parts. Do not touch the fan or motor during operation. Do not lean over the motor.

☐ Project #127 Blowing Fan

OBJECTIVE: To build a fan that won't come off.

Modify the circuit from project #126 by reversing the position of the motor (M1), so the positive (+) side is towards the PNP (Q1). Turn it on, and set the adjustable resistor (RV) for the fan speed you like best. Set it for full speed and see if the fan flies off - it won't! The fan is blowing air upward now! Try holding a piece of paper just above the fan to prove this.

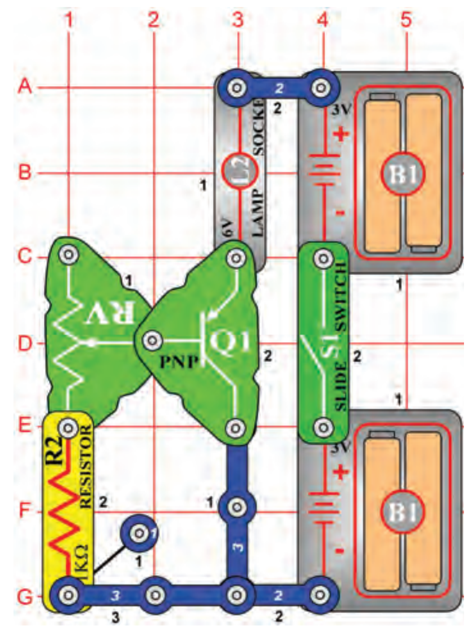
☐ Project #128 PNP Collector



OBJECTIVE: To demonstrate adjusting the gain of a transistor circuit.

Build the circuit and vary the lamp (L2) brightness with the adjustable resistor (RV), it will be off for most of the resistor's range. The point on the PNP (Q1) that the lamp is connected to (point E4 on the base grid) is called the collector, hence the name for this project.

☐ Project #129 PNP Emitter

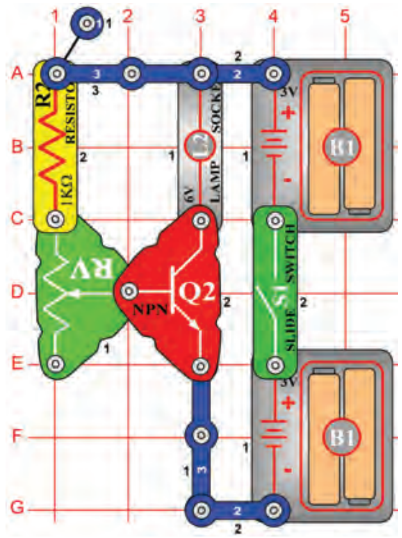


OBJECTIVE: To compare transistor circuits.

Compare this circuit to that in project #128. The maximum lamp (L2) brightness is less here because the lamp resistance reduces the emitter-base current, which contacts the emitter-collector current (as per project #128). The point on the PNP (Q1) that the lamp is now connected to (grid point C4) is called the emitter.

Project #130

NPN Collector

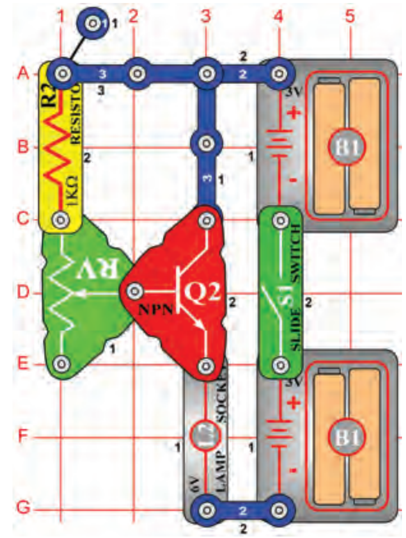


OBJECTIVE: To compare transistor circuits.

Compare this circuit to that in project #128, it is the NPN transistor (Q2) version and works the same way. Which circuit makes the lamp (L2) brighter? (They are about the same because both transistors are made from the same materials).

Project #131

NPN Emitter

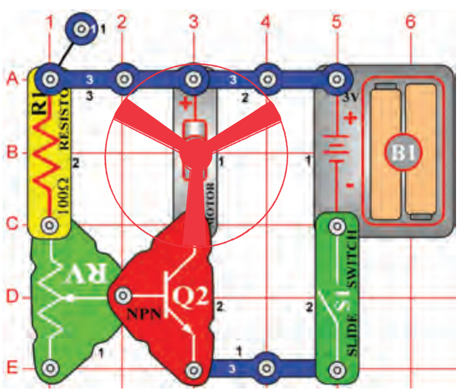


OBJECTIVE: To compare transistor circuits.

Compare this circuit to that in project #129. It is the NPN transistor (Q2) version and works the same way. The same principles apply here as in projects #128-#130, so you should expect it to be less bright than #130 but as bright as #129.

Project #132

NPN Collector - Motor



OBJECTIVE: To compare transistor circuits.

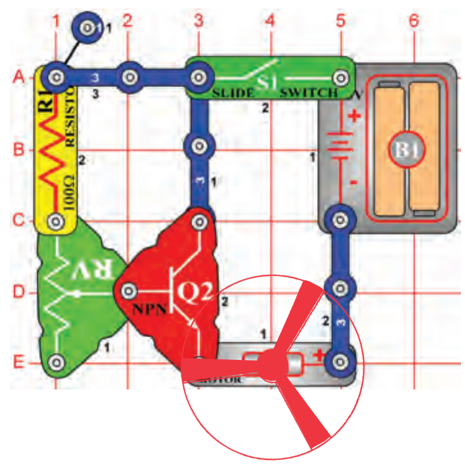
This is the same circuit as in project #130, except that it has the motor (M1) instead of the lamp. Place the motor with the positive (+) side touching the NPN and put the fan on it.

The fan will not move on most settings of the resistor, because the resistance is too high to overcome friction in the motor. If the fan does not move at any resistor setting, then replace your batteries.

WARNING: Moving parts. Do not touch the fan or motor during operation. Do not lean over the motor.

Project #133

NPN Emitter - Motor

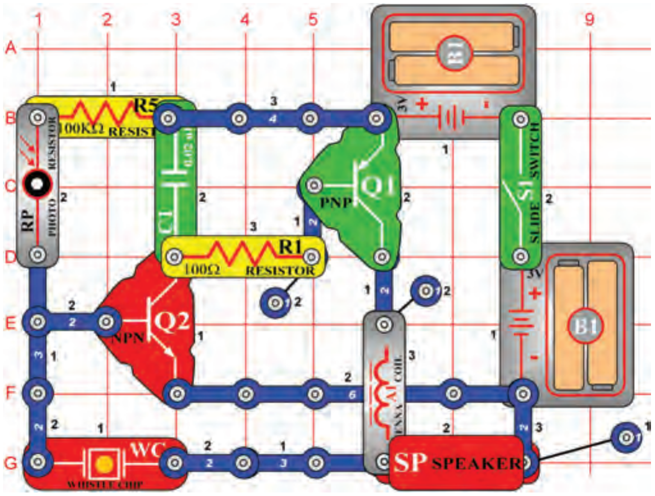


OBJECTIVE: To compare transistor circuits.

This is the same circuit as in project #131, except that it has the motor (M1) instead of the lamp. Place the motor with the positive (+) side to the right and put the fan on it. Compare the fan speed to that in project #132. Just as the lamp was dimmer in the emitter configuration, the motor is not as fast now.

WARNING: Moving parts. Do not touch the fan or motor during operation. Do not lean over the motor.

☐ Project #134 Buzzing in the Dark



OBJECTIVE: To make a circuit that buzzes when the lights are off.

This circuit makes a high-frequency screaming sound when light shines on the photoresistor (RP), and makes a buzzing sound when you shield the photoresistor.

☐ Project #135 Touch Buzzer

OBJECTIVE: To build a human buzzer oscillator.

Remove the photoresistor (RP) from the circuit in project #134 and instead touch your fingers across where it used to be (points B1 and D1 on the grid) to hear a cute buzzing sound.
The circuit works because of the resistance in your body. If you put back the photoresistor and partially cover it, you should be able to make the same resistance your body did, and get the same sound.

☐ Project #136 High Frequency Touch Buzzer

OBJECTIVE: To build a high frequency human buzzer oscillator.

Replace the speaker (SP) with the 6V lamp (L2). Now touching your fingers between B1 and D1 creates a quieter but more pleasant buzzing sound.

☐ Project #137 High Frequency Water Buzzer

OBJECTIVE: To build a high frequency water buzzer oscillator.

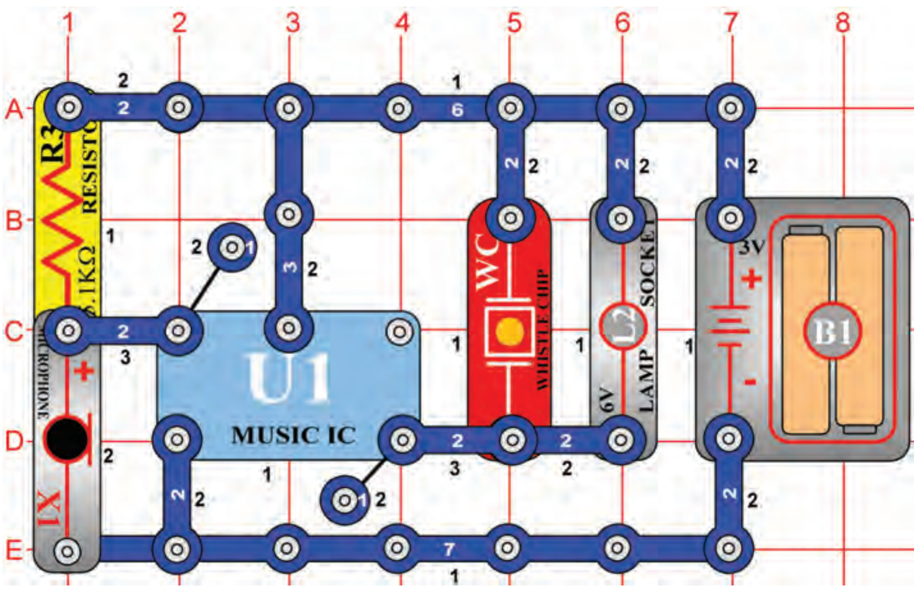
Now connect two (2) jumpers to points B1 and D1 (that you were touching with your fingers) and place the loose ends into a cup of water. The sound will not be much different now, because your body is mostly water and so the circuit resistance has not changed much.

☐ Project #138 Mosquito

OBJECTIVE: To make a buzz like a mosquito.

Place the photoresistor (RP) into the circuit in project #137 across where you were connecting the jumpers (points B1 and D1 on the grid, and as shown in project #134). Now the buzz sounds like a mosquito.

Project #139 High Sensitivity Voice Doorbell



OBJECTIVE: To build a highly sensitive voice-activated doorbell.

Build the circuit and wait until the sound stops. Clap or talk loud a few feet away and the music plays again. The microphone (X1) is used here because it is very sensitive.

Project #140 Louder Doorbell

OBJECTIVE: To build a loud highly sensitive voice-activated doorbell.

Replace the 6V lamp (L2) with the antenna coil (A1), the sound is louder now.

Project #141 Very Loud Doorbell

OBJECTIVE: To build a very loud, highly-sensitive, voice-activated doorbell.

Replace the antenna coil (A1) with the speaker (SP), the sound is much louder now.

Project #142 Doorbell with Button

OBJECTIVE: To build a press-activated doorbell.

Replace the microphone (X1) with the press switch (S2) and wait until the music stops. Now you have to press the slide switch (S1) to activate the music, just like the doorbell on your house.

Project #143 Darkness Announcer

OBJECTIVE: To play music when it gets dark.

Replace the press switch (S2) with the photoresistor (RP) and wait until the sound stops. If you cover the photoresistor now the music will play once, signaling that it has gotten dark. If the speaker (SP) is too loud then you may replace it with the antenna coil (A1).

Project #144 Musical Motion Detector

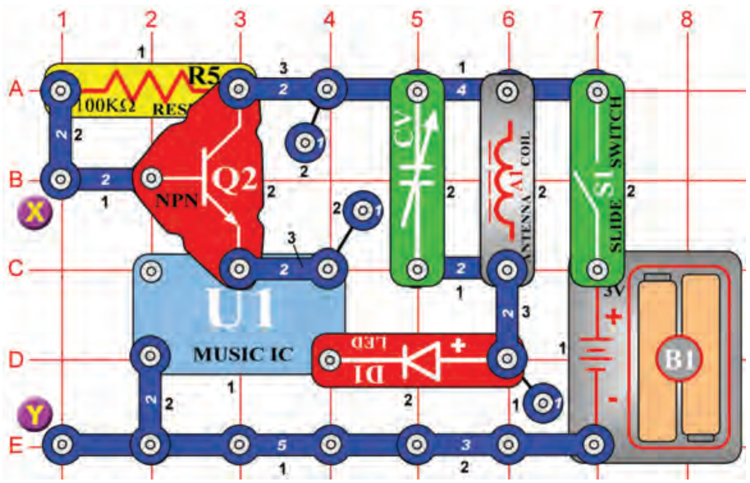
OBJECTIVE: To detect when someone spins the motor.

Replace the photoresistor (RP) with the motor (M1), oriented in either direction. Now spinning the motor will re-activate the music.

☐ Project #145

Radio Music Alarm

OBJECTIVE: To build a radio music alarm.



You need an AM radio for this project. Build the circuit on the left and turn on the slide switch (S1). Place it next to your AM radio and tune the radio frequency to where no other station is transmitting. Then, tune the adjustable capacitor (CV) until your music sounds best on the radio. Now connect a jumper wire between X and Y on the drawing, the music stops.

If you remove the jumper now, the music will play indicating your alarm wire has been triggered. You could use a longer wire and wrap it around a bike, and use it as a burglar alarm!

☐ Project #146

Daylight Music Radio

OBJECTIVE: To build a light-controlled radio transmitter.

Remove the jumper wire. Replace the 100kΩ resistor (R5) with the photoresistor (RP). Now your AM radio will play music as long as there is light in the room.

☐ Project #147

Night Music Radio

OBJECTIVE: To build a dark-controlled radio transmitter.

Put the 100kΩ resistor back in as before and instead connect the photoresistor between X & Y (you also need a 1-snap and a 2-snap wire to do this). Now your radio plays music when it is dark.

☐ Project #148

Night Gun Radio

OBJECTIVE: To build a dark-controlled radio transmitter.

Replace the music IC (U1) with the alarm IC (U2). Now your radio plays the sound of a machine gun when it is dark.

☐ Project #149

Radio Gun Alarm

OBJECTIVE: To build a radio alarm.

Remove the photoresistor (RP). Now connect a jumper wire between X & Y on the drawing.
If you remove the jumper now, the machine gun sound will play on the radio indicating your alarm wire has been triggered.

☐ Project #150

Daylight Gun Radio

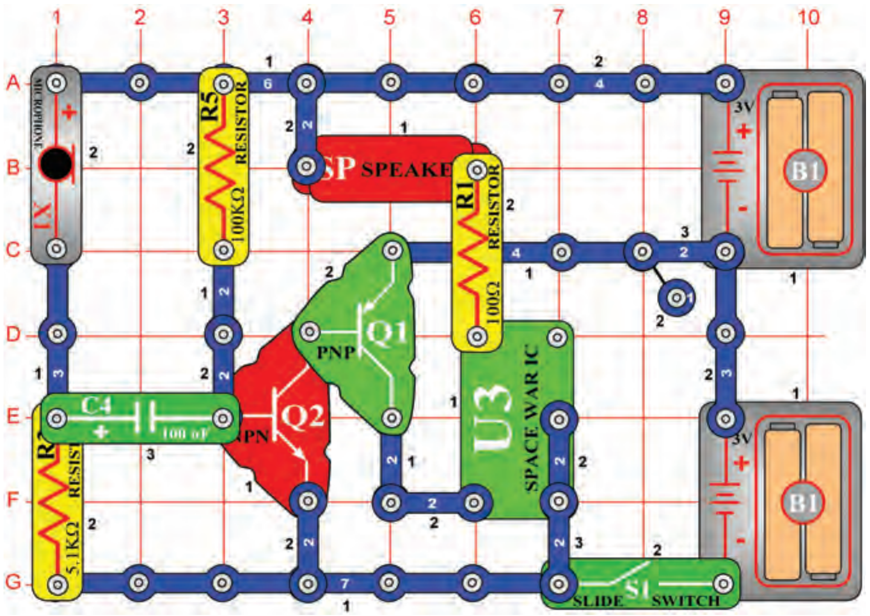
OBJECTIVE: To build a light-controlled radio transmitter.

Remove the jumper wire. Replace the 100kΩ resistor (R5) with the photoresistor (RP). Now your AM radio will play the machine gun sound as long as there is light in the room.

Project #151

Blow Off a Space War

OBJECTIVE: To turn off a circuit by blowing on it.

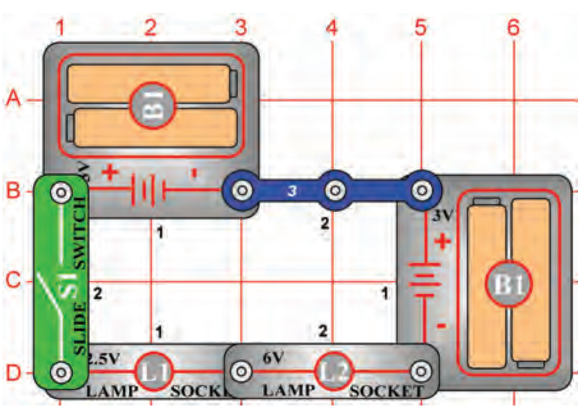


Build the circuit and turn it on, you hear a space war. Since it is loud and annoying, try to shut it off by blowing into the microphone (X1). Blowing hard into the microphone stops the sound, and then it starts again.

Project #152

Series Lamps

OBJECTIVE: To compare types of circuits.

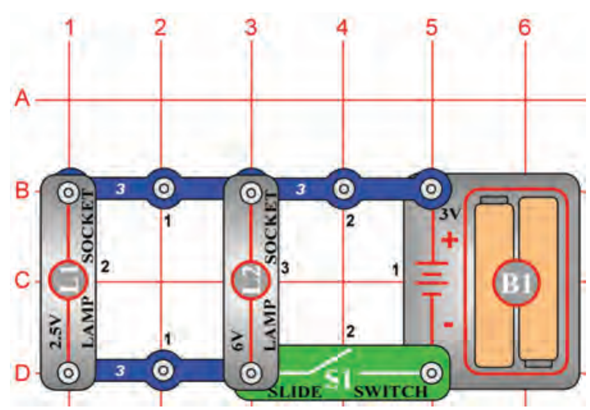


Turn on the slide switch (S1) and both lamps (L1 & L2) will light. If one of the bulbs is broken then neither will be on, because the lamps are in series. An example of this is the strings of small Christmas lights; if one bulb is damaged then the entire string does not work.

Project #153

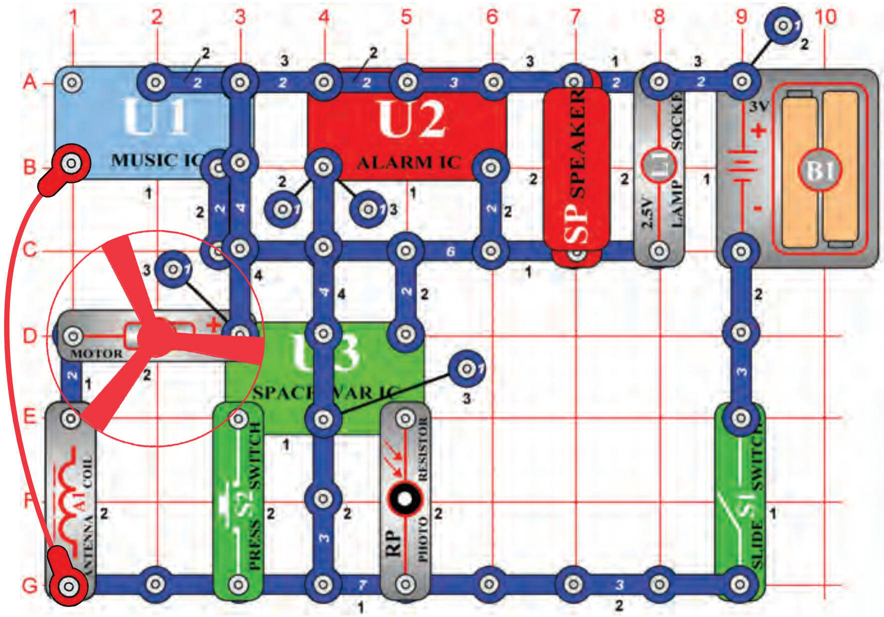
Parallel Lamps

OBJECTIVE: To compare types of circuits.



Turn on the slide switch (S1) and both lamps (L1 & L2) will light. If one of the bulbs is broken then the other will still be on, because the lamps are in parallel. An example of this is most of the lights in your house; if a bulb is broken on one lamp then the other lamps are not affected.

Project #154 Fire Fan Symphony



***OBJECTIVE:** To combine sounds from the music, alarm, and space war integrated circuits.*

Build the circuit shown and add the jumper to complete it. Note that in one place two (2) single snaps are stacked on top of each other. Also, note that there is a 2-snap wire on layer 2 that does not connect with a 4-snap wire that runs over it on layer 4 (both touch the music IC). Turn it on and press the press switch (S2) several times and wave your hand over the photoresistor (RP) to hear the full spectrum of sounds that this circuit can create. Have fun!

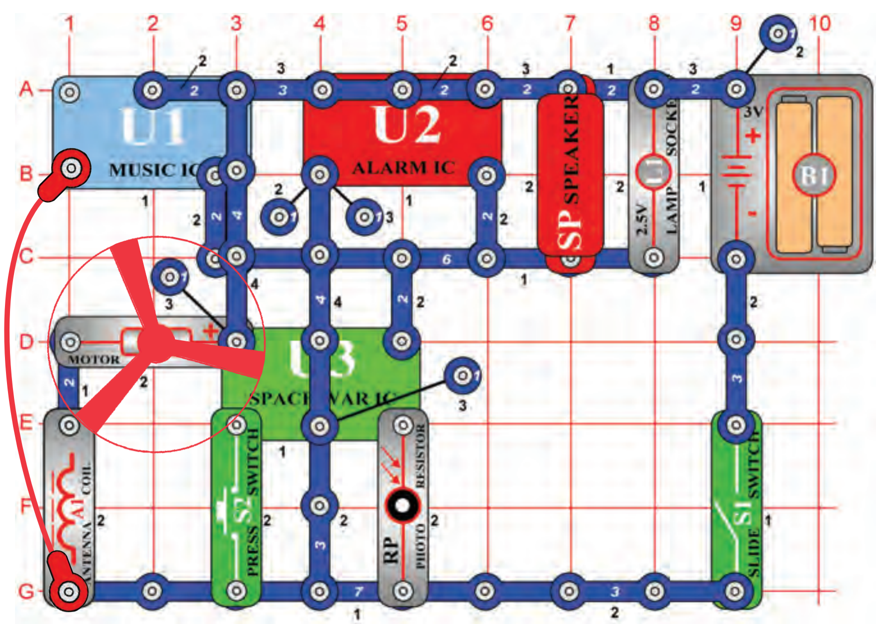
WARNING: Moving parts. Do not touch the fan or motor during operation. Do not lean over the motor.

Project #155 Fire Fan Symphony (II)

OBJECTIVE:
See project #154.

The preceding circuit may be too loud, so replace the speaker (SP) with the whistle chip (WC).

Project #156 Fan Symphony



***OBJECTIVE:** To combine sounds from the music, alarm, and space war integrated circuits.*

Modify the circuit from project #154 to match the circuit shown on the left. The only differences are the connections around the alarm IC (U2). It works the same way.

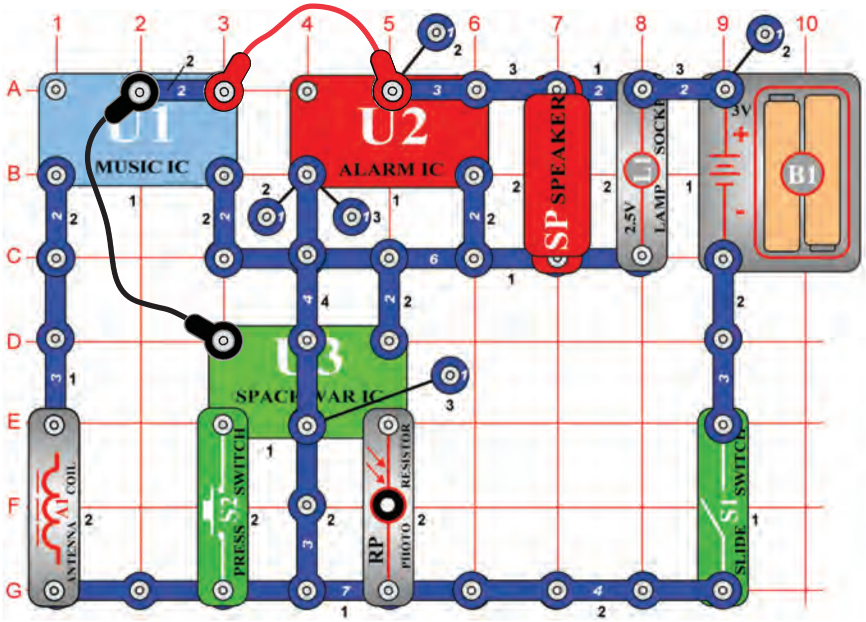
WARNING: Moving parts. Do not touch the fan or motor during operation. Do not lean over the motor.

Project #157 Fan Symphony (II)

OBJECTIVE:
See project #156.

The preceding circuit may be too loud, so replace the speaker (SP) with the whistle chip (WC).

Project #158 Police Car Symphony



OBJECTIVE: To combine sounds from the integrated circuits.

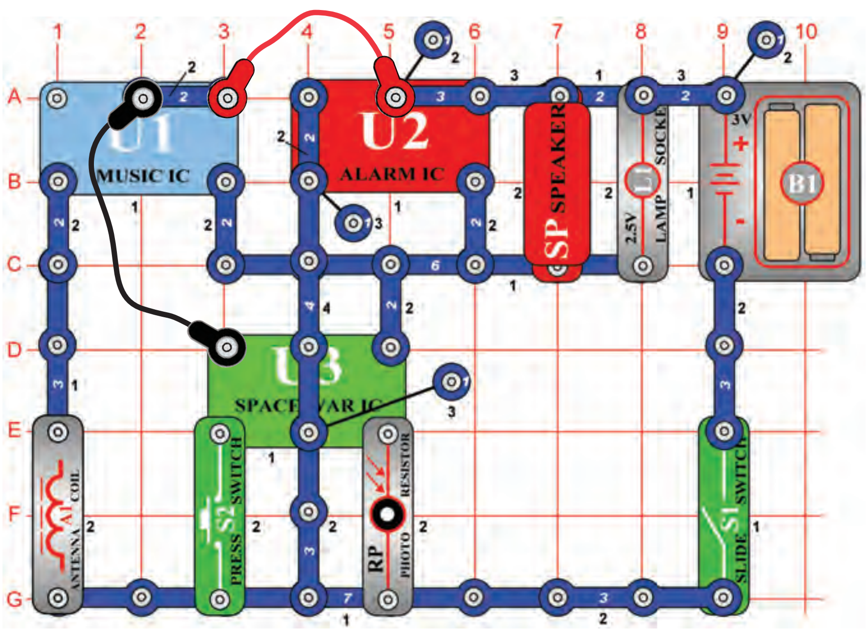
Build the circuit shown and add the two (2) jumper wires to complete it. Note that in one place two (2) single snaps are stacked on top of each other. Turn it on and press the press switch (S2) several times and wave your hand over the photoresistor (RP) to hear the full spectrum of sounds that this circuit can create. Have fun!
Do you know why the antenna (A1) is used in this circuit? It is being used as just a 3-snap wire, because it acts like an ordinary wire in low frequency circuits such as this. Without it, you don't have enough parts to build this complex circuit.

Project #159 Police Car Symphony (II)

OBJECTIVE:
See project #158.

The preceding circuit may be too loud, so replace the speaker (SP) with the whistle chip (WC).

Project #160 Ambulance Symphony



OBJECTIVE: To combine sounds from the music, alarm, and space war integrated circuits.

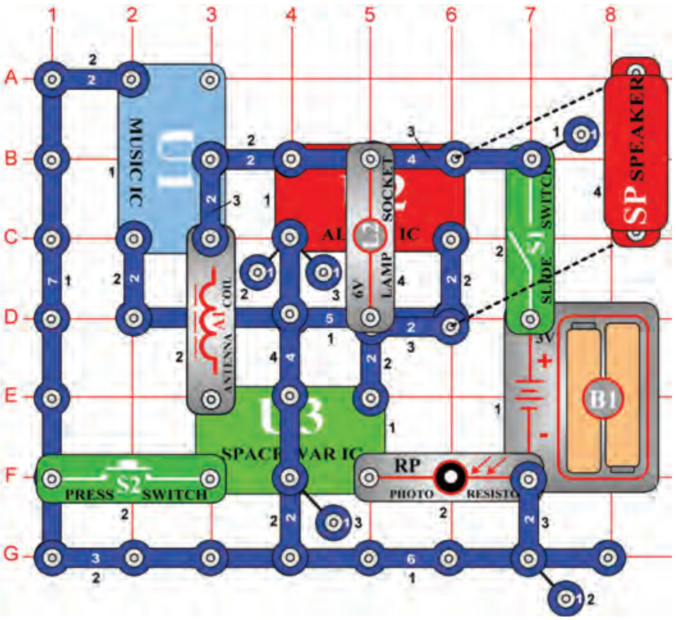
Modify the circuit from project #158 to match the circuit shown on the left. The only differences are the connections around the alarm IC (U2). It works the same way.

Project #161 Ambulance Symphony (II)

OBJECTIVE:
See project #160.

The preceding circuit may be too loud, so replace the speaker (SP) with the whistle chip (WC).

☐ Project #162 Static Symphony



***OBJECTIVE:** To combine sounds from the integrated circuits.*

Build the circuit shown. Note that in some places parts are stacked on top of each other. Turn it on and press the press switch (S2) several times and wave your hand over the photoresistor (RP) to hear the full spectrum of sounds that this circuit can create. Have fun!

☐ Project #163 Static Symphony (II)

***OBJECTIVE:** See project #162.*

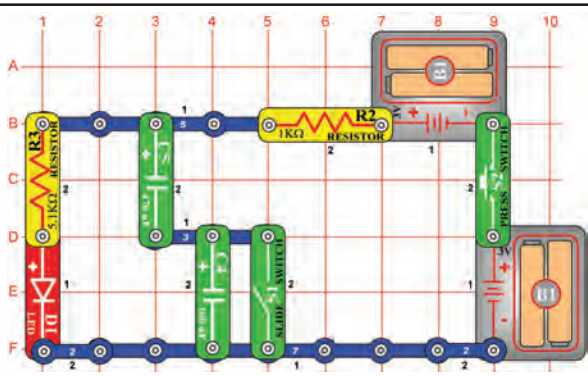
For a variation on the preceding circuit, you can replace the 6V lamp (L2) with the LED (D1), with the positive (+) side up, or the motor (M1) (do not place the fan on it).

☐ Project #164 Capacitors in Series

***OBJECTIVE:** To compare types of circuits.*

Turn on the slide switch (S1), then press and release the press switch (S2). The LED (D1) becomes bright when the 470μF capacitor charges up with the press switch on, then the LED slowly gets dim after you release the press switch.

Now turn off the slide switch. Repeat the test with the slide swtich off; you'll notice the LED goes out much faster after you release the press switch. The much smaller 100μF capacitor (C4) is now in series with the 470μF and so reduces the total capacitance (electrical storage capacity), and they discharge much faster. (Note that this is opposite to how resistors in series work).

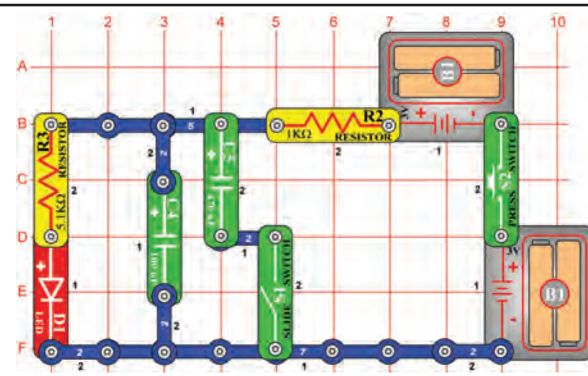


☐ Project #165 Capacitors in Parallel

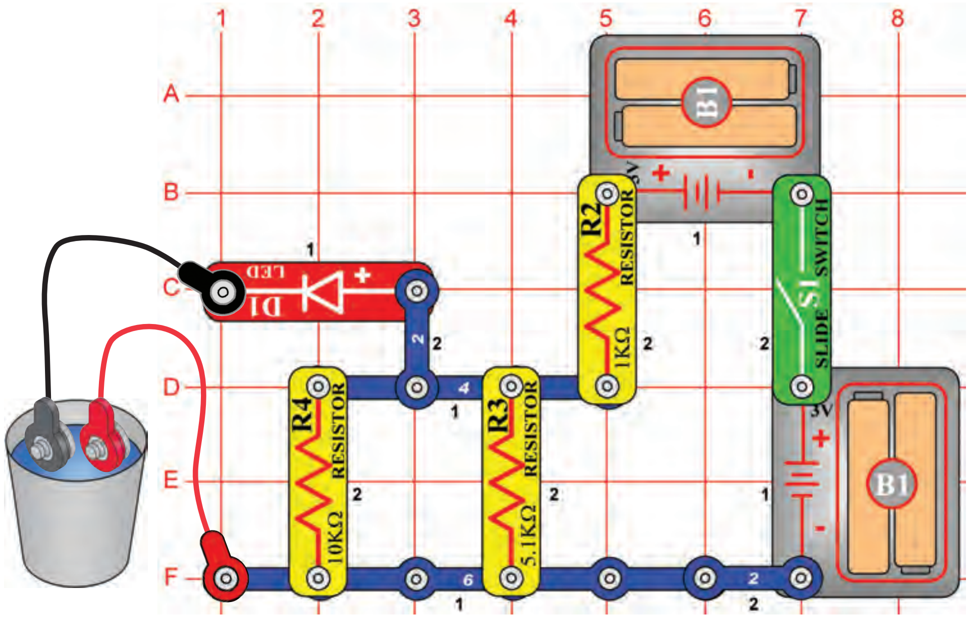
***OBJECTIVE:** To compare types of circuits.*

Turn off the slide switch (S1), then press and release the press switch (S2). The LED (D1) becomes bright when the 100μF capacitor charges up with the press switch on, then the LED slowly gets dim after you release the press switch.

Now turn on the slide switch and repeat the test; you'll notice the LED goes out much slower after you release the press switch. The much larger 470μF capacitor (C5) is now in parallel with the 100μF and so increases the total capacitance (electrical storage capacity), and they discharge much slower. (Note that this is opposite to how resistors in parallel work.)



Project #166 Water Detector



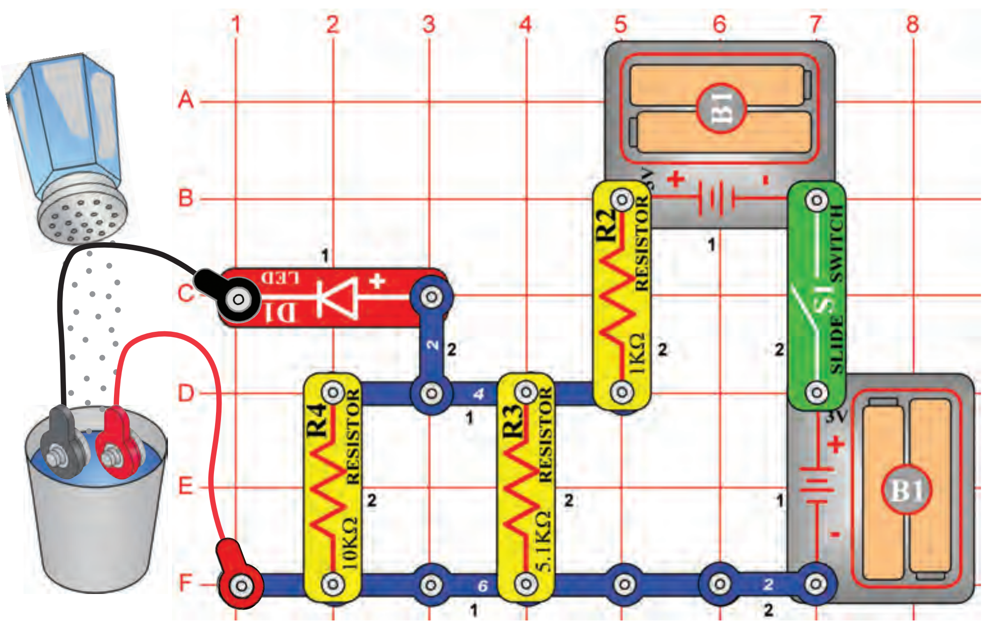
OBJECTIVE: To show how water conducts electricity.

Build the circuit at left and connect the two jumpers to it, but leave the loose ends of the jumpers lying on the table initially. Turn on the slide switch (S1) - the LED (D1) will be dark because the air separating the jumpers has very high resistance. Touch the loose jumper ends to each other and the LED will be bright, because with a direct connection there is no resistance separating the jumpers.

Now take the loose ends of the jumpers and place them in a cup of water, without letting them touch each other. The LED should be dimly lit, indicating you have detected water!

For this experiment, your LED brightness may vary depending upon your local water supply. Pure water (like distilled water) has very high resistance, but drinking water has impurities mixed in that increase electrical conduction.

Project #167 Saltwater Detector

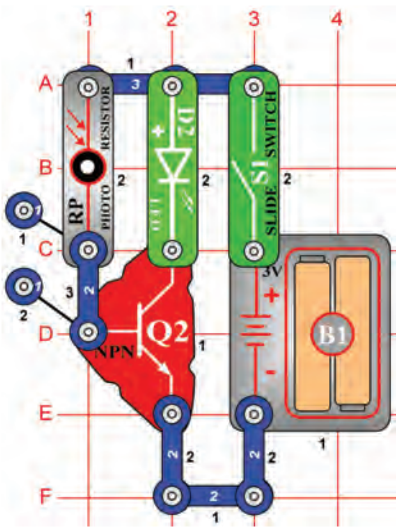


OBJECTIVE: To show how adding salt to water changes water's electrical characteristics.

Place the jumpers in a cup of water as in the preceding project; the LED (D1) should be dimly lit. Slowly add salt to the water and see how the LED brightness changes, mix it a little so it dissolves. It will slowly become very bright as you add more salt. You can use this bright LED condition as a saltwater detector! You can then reduce the LED brightness by adding more water to dilute the salt.

Take another cup of water and try adding other household substances like sugar to see if they increase the LED brightness as the salt did.

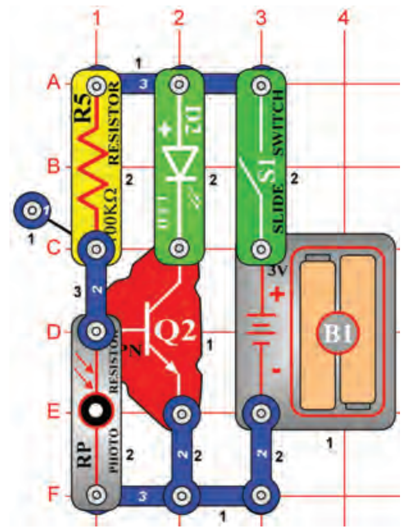
Project #168
NPN Light Control



OBJECTIVE: To compare transistor circuits.

Turn on the slide switch (S1), the brightness of the LED (D2) depends on how much light shines on the photoresistor (RP). The resistance drops as more light shines, allowing more current to the NPN (Q2).

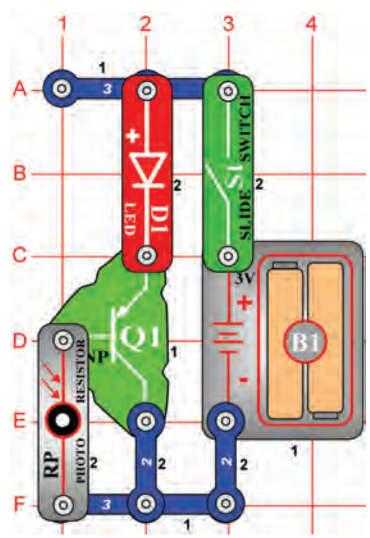
Project #169
NPN Dark Control



OBJECTIVE: To compare transistor circuits.

Turn on the slide switch (S1), the brightness of the LED (D2) depends on how LITTLE light shines on the photoresistor (RP). The resistance drops as more light shines, diverting current away from the NPN (Q2).

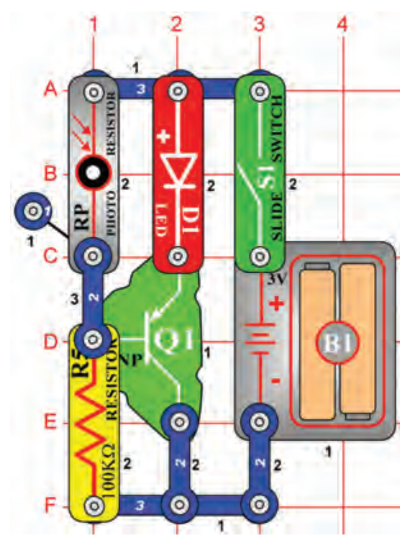
Project #170
PNP Light Control



OBJECTIVE: To compare transistor circuits.

Turn on the slide switch (S1), the brightness of the LED (D1) depends on how much light shines on the photoresistor (RP). The resistance drops as more light shines, allowing more current through the PNP (Q1). This is similar to the NPN (Q2) circuit above.

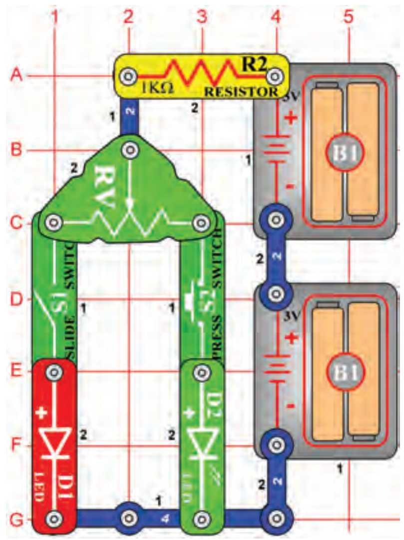
Project #171
PNP Dark Control



OBJECTIVE: To compare transistor circuits.

Turn on the slide switch (S1), the brightness of the LED (D1) depends on how LITTLE light shines on the photoresistor (RP). The resistance drops as more light shines, so more current gets to the 100kΩ resistor (R5) from the photoresistor path and less from the PNP-diode path. This is similar to the NPN circuit above.

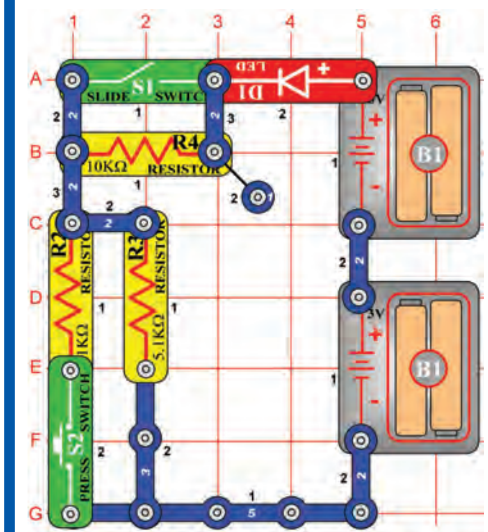
Project #172
Red & Green Control



OBJECTIVE: To demonstrate how the adjustable resistor works.

Turn on the circuit using the slide switch (S1) and/or the press switch (S2) and move the adjustable resistor's (RV) control lever around to adjust the brightness of the LED's (D1 & D2). When the adjustable resistor is set to one side, that side will have low resistance and its LED will be bright (assuming the switch on that side is ON) while the other LED will be dim or OFF.

Project #173
Current Controllers



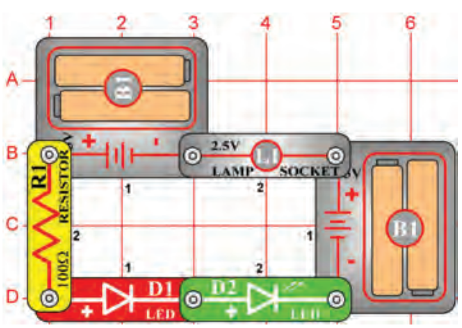
OBJECTIVE: To compare types of circuits.

Build the circuit and turn on the slide switch (S1), the LED (D1) will be lit. To increase the LED brightness, turn on the press switch (S2). To decrease the LED brightness, turn off the slide switch.

With the slide switch on, the 5.1KΩ resistor (R3) controls the current. Turning on the press switch places the 1KΩ resistor (R2) in parallel with it to decrease the total circuit resistance. Turning off the slide switch places the 10KΩ resistor (R4) in series with R2/R3 to increase the total resistance.

Project #174
Current Equalizing

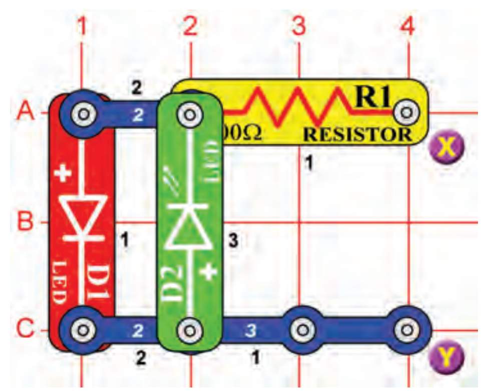
OBJECTIVE: To compare types of circuits.



In this circuit the LED's (D1 & D2) will have the same brightness, but the lamp (L1) will be off. When connected in series, all components will have equal electric current through them. The lamp is off because it requires a higher current through the circuit to turn on than the LED's do.

Project #175
Battery Polarity Tester

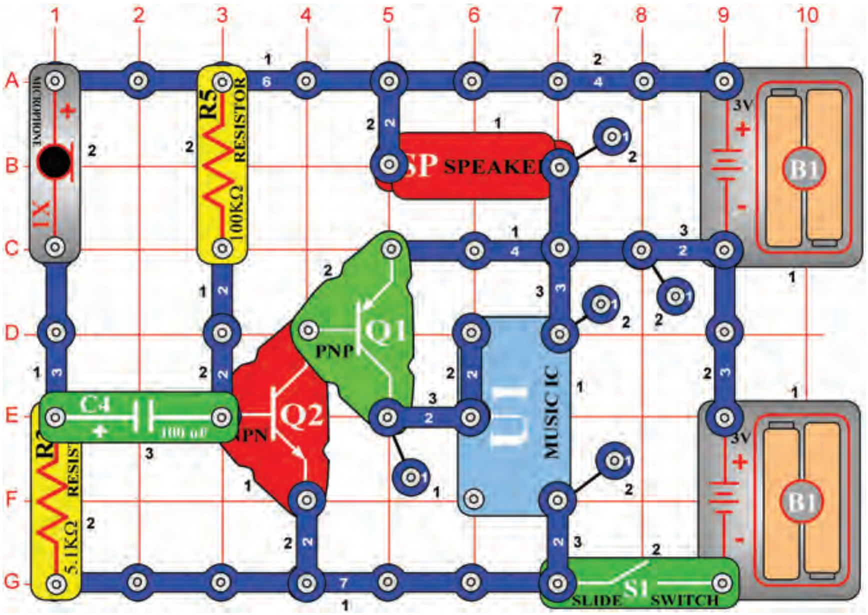
OBJECTIVE: To test the polarity of a battery.



Use this circuit to check the polarity of a battery. Connect your battery to X & Y on the drawing using the jumper cables (your 3V battery pack (B1) can also be snapped on directly instead). If the positive (+) side of your battery is connected to X, then the red LED (D1) will be on, if the negative (–) side is connected to X then the green LED (D2) will be on.

☐ Project #176 Blow Off a Doorbell

OBJECTIVE: To turn off a circuit by blowing on it.



Build the circuit and turn it on; music plays. Since it is loud and annoying, try to shut it off by blowing into the microphone (X1). Blowing hard into the microphone stops the music, and then it starts again.

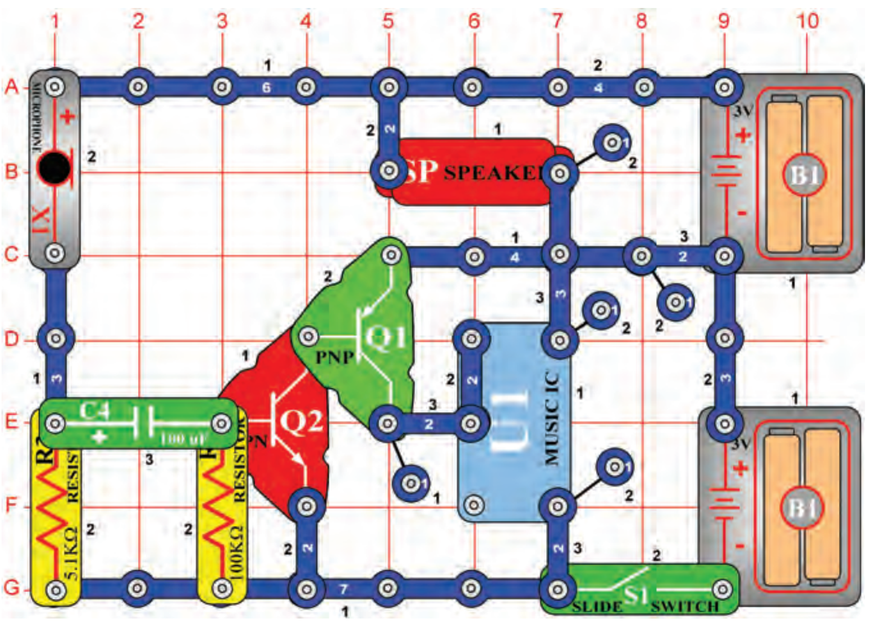
☐ Project #177 Blow Off a Candle

OBJECTIVE: To turn off a circuit by blowing on it.

Replace the speaker (SP) with the 6V lamp (L2). Blowing hard into the microphone (X1) turns off the light briefly.

☐ Project #178 Blow On a Doorbell

OBJECTIVE: To turn on a circuit by blowing on it.



Build the circuit and turn it on, music plays for a few moments and then stops. Blow into the microphone (X1) and it plays; it plays as long as you keep blowing.

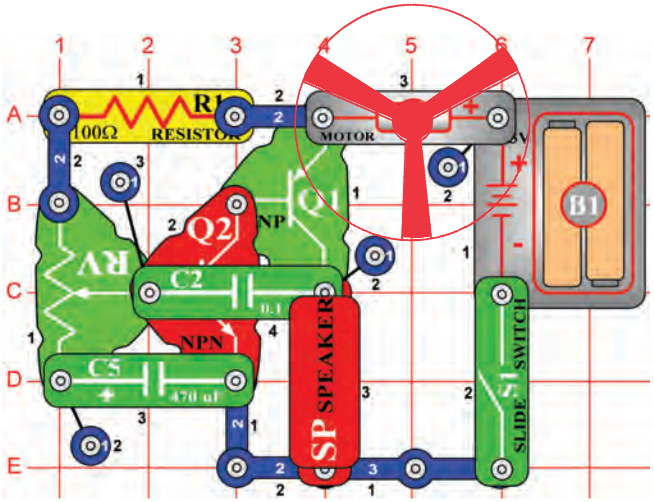
☐ Project #179 Blow On a Candle

OBJECTIVE: To turn on a circuit by blowing on it.

Replace the speaker (SP) with the 6V lamp (L2). Blowing into the microphone (X1) turns on the light, and then it goes off again.

☐ Project #180 Screaming Fan

OBJECTIVE: To have an adjustable resistance control a fan and sounds.



Build the circuit on the left and place the fan onto the motor (M1). Turn on the slide switch (S1) and move the setting on the adjustable resistor (RV) across its range. You hear screaming sounds and the fan spins.

WARNING: Moving parts. Do not touch the fan or motor during operation. Do not lean over the motor.

☐ Project #181 Whining Fan

OBJECTIVE: To make different sounds.

Replace the 0.1μF capacitor (C2) with the 0.02μF capacitor (C1). The sounds are now a high-pitch whine and the motor (M1) starts a little sooner.

☐ Project #182 Light Whining

OBJECTIVE: To make different sounds.

Replace the 100Ω resistor (R1) at the upper-left of the circuit (points A1 & A3 on the base grid) with the photoresistor (RP), and wave your hand over it. The whining sound has changed a little and can now be controlled by light.

☐ Project #183 More Light Whining

OBJECTIVE: To make different sounds.

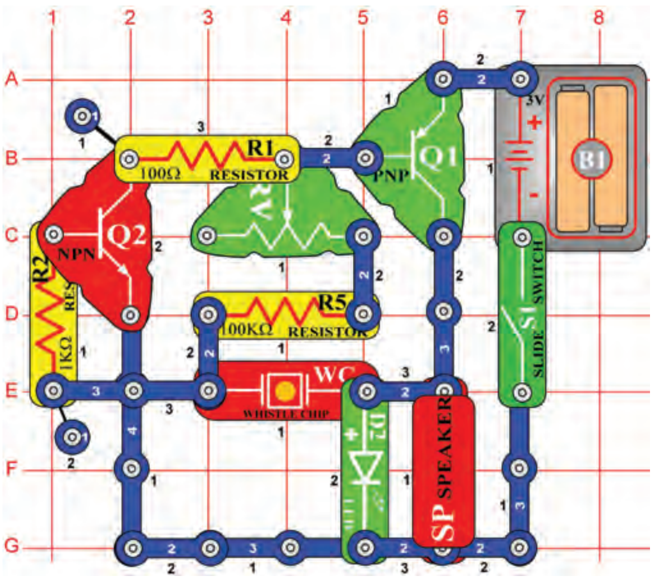
Replace the 0.02μF capacitor (C1) with the 0.1μF capacitor (C2). The sounds are lower in frequency and you can't make the fan spin now.

☐ Project #184 Motor That Won't Start

OBJECTIVE: To make different sounds.

Replace the 0.1μF capacitor (C2) with the 10μF capacitor (C3), put the positive (+) side towards the left). It now makes clicking sounds and the fan moves only in small bursts, like a motor that won't start.

☐ Project #185 Whiner



OBJECTIVE: To build a circuit that makes a loud whine.

Build the circuit, turn it on, and move the setting on the adjustable resistor (RV). It makes a loud, annoying whine sound. The green LED (D2) appears to be on, but it is actually flashing at a very fast rate.

☐ Project #186 Lower Pitch Whiner

OBJECTIVE: To show how adding capacitance reduces frequency.

Place the 0.02μF capacitor (C1) above the whistle chip (WC) and vary the adjustable resistor (RV) again. The frequency (or pitch) of the whine has been reduced by the added capacitance.

☐ Project #187 Hummer

OBJECTIVE: To show how adding capacitance reduces frequency.

Now place the 0.1μF capacitor (C2) above the whistle chip (WC) and vary the adjustable resistor (RV) again. The frequency (or pitch) of the whine has been reduced by the greater added capacitance and it sounds more like a hum now.

☐ Project #188 Adjustable Metronome

OBJECTIVE: To build an adjustable electronic metronome.

Now place the 10μF capacitor (C3, "+" side on right) above the whistle chip (WC) and vary the adjustable resistor (RV) again. There is no hum now but instead there is a click and a flash of light repeating about once a second, like the "beat" of a sound. It is like a metronome, which is used to keep time for the rhythm of a song.

☐ Project #189 Quiet Flasher

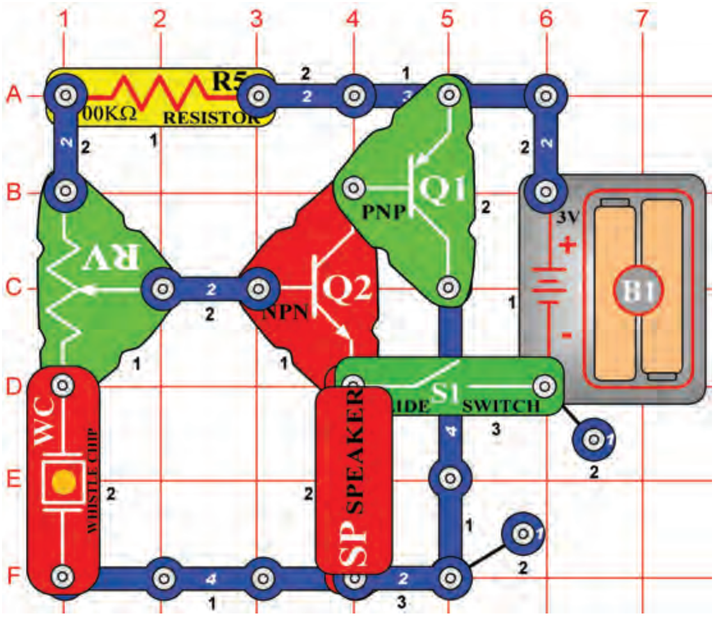
OBJECTIVE: To make a blinking flashlight.

Leave the 10μF capacitor (C3) connected but replace the speaker (SP) with the 2.5V lamp (L1).

Project #190

Hissing Foghorn

OBJECTIVE: To build a transistor oscillator that can make a foghorn sound.



Build the circuit on the left and move the adjustable resistor (RV) setting. Sometimes it will make a foghorn sound, sometimes it will make a hissing sound, and sometimes it will make no sound at all.

Project #191

Hissing & Clicking

OBJECTIVE: To build an adjustable clicking oscillator.

Modify the circuit in project #190 by replacing the 100kΩ resistor (R5) with the photoresistor (RP).
Move the adjustable resistor (RV) setting until you hear hissing sounds, and then shield the photoresistor while doing so and you hear clicking sounds.

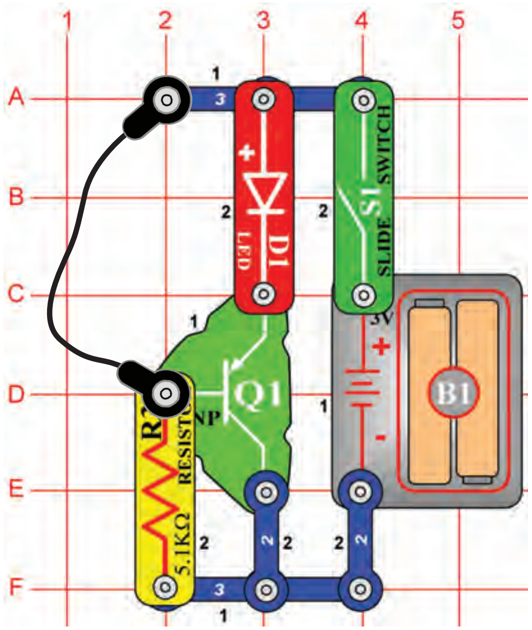
Project #192

Video Game Engine Sound

OBJECTIVE: To build a human oscillator.

Remove the photoresistor (RP) from the circuit in project #191 and instead touch your fingers between the contacts at points A4 and B2 on the base grid while moving the adjustable resistor (RV). You hear a clicking that sounds like the engine sound in auto-racing video games.

Project #193 Light Alarm



OBJECTIVE: To build a transistor light alarm.

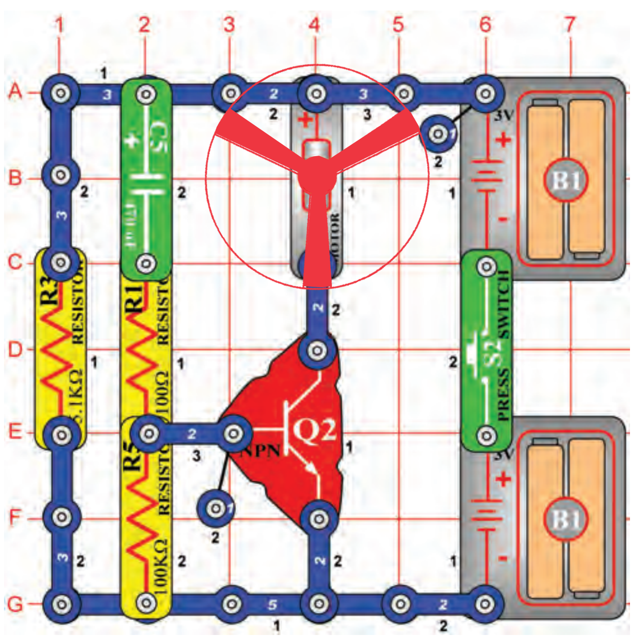
Build the circuit with the jumper connected as shown, and turn it on. Nothing happens. Break the jumper connection and the light turns on. You could replace the jumper with a longer wire and run it across a doorway to signal an alarm when someone enters.

Project #194 Brighter Light Alarm

OBJECTIVE: To build a brighter transistor light alarm.

Modify the circuit in project #193 by replacing the LED (D1) with the 2.5V lamp (L1) and replacing the 5.1kΩ resistor (R3) with the 100Ω resistor (R1). It works the same way but is brighter now.

Project #195 Lazy Fan



OBJECTIVE: To build a fan that doesn't work well.

Press the press switch (S2) and the fan will be on for a few turns. Wait a few moments and press again, and the fan will make a few more turns.

WARNING: Moving parts. Do not touch the fan or motor during operation. Do not lean over the motor.

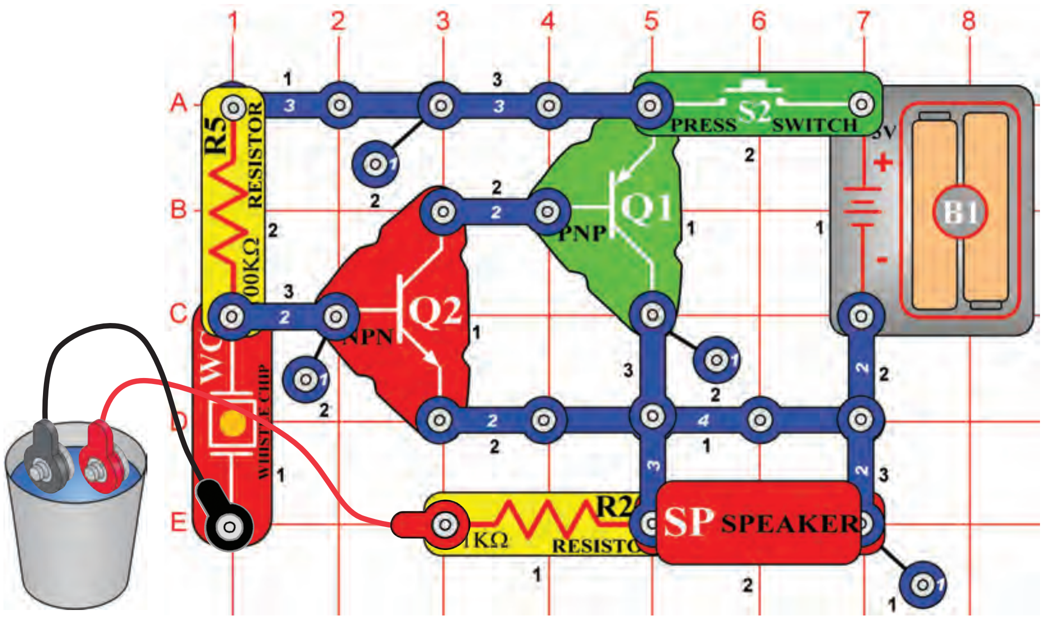
Project #196 Laser Light

OBJECTIVE: To build a simple laser.

Replace the motor (M1) with the 6V lamp (L2). Now pressing the press switch (S2) creates a blast of light like a laser.

Project #197 — Water Alarm

OBJECTIVE: To sound an alarm when water is detected, tone will vary with salt content.

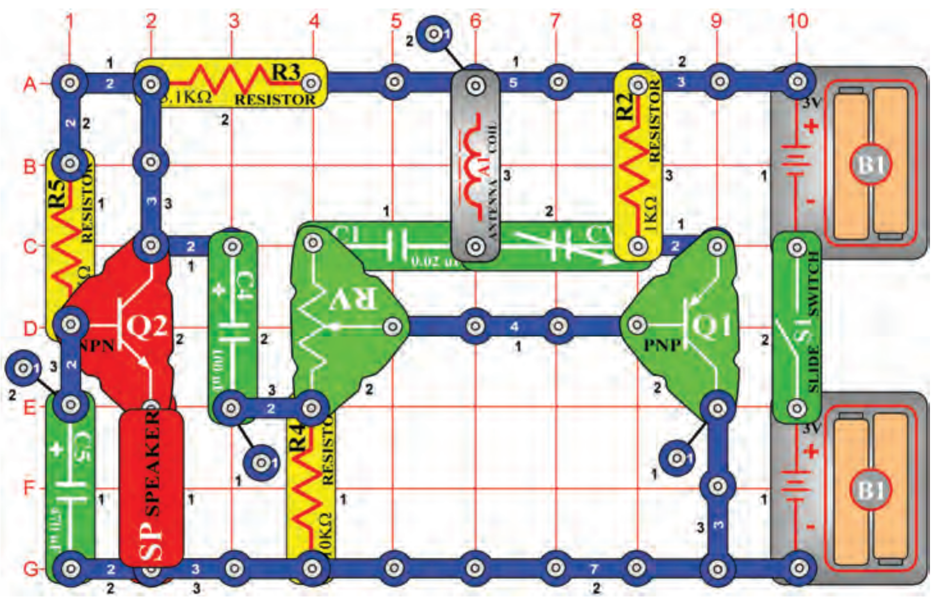


Build the circuit at left and connect the two (2) jumpers to it, place the loose ends of the jumpers into an empty cup (without them touching each other). Press the press switch (S2) - nothing happens. Add some water to the cup and an alarm will sound. Add salt to the water and the tone changes.

You can also test different liquids and see what tone they produce.

Project #198 — Radio Announcer

OBJECTIVE: To hear your voice on the radio.

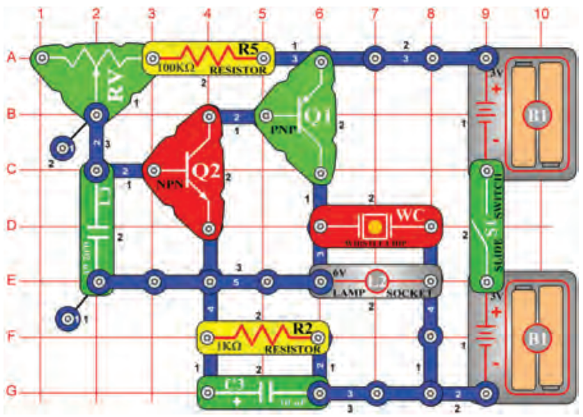


You need an AM radio for this project. Build the circuit shown but do not turn on the slide switch (S1). Place it within a foot of your AM radio and tune the radio frequency to the middle of the AM band (around 1000 kHz), where no other station is transmitting. Turn the volume up so you can hear the static. Set the adjustable resistor (RV) control to the middle setting. Turn on the slide switch and slowly tune the adjustable capacitor (CV) until the static on the radio becomes quiet. You may hear a whistle as you approach the proper tuning. In some cases you may also need to set the adjustable resistor slightly off-center.

When the radio static is gone, tap on the speaker (SP) with your finger and you should hear the sound of tapping on the radio. Now talk loudly into the speaker (used here as a microphone) and you will hear your voice on the radio. Set the adjustable resistor for best sound quality at the radio.

☐ Project #199 Pitch

OBJECTIVE: To show how to change the pitch of a sound.



Build the circuit on the left, turn it on, and vary the adjustable resistor (RV). The *frequency* or *pitch* of the sound is changed. Pitch is the musical profession's word for frequency. If you've had music lessons, you may remember the music scale using chords such as A3, F5, and D2 to express the *pitch* of a sound. Electronics prefers the term *frequency*, as in when you adjust the frequency on your radio.

☐ Project 200 Pitch (II)

OBJECTIVE: See project #199.

Since we've seen we can adjust the frequency by varying the resistance in the adjustable resistor, are there other ways to change the frequency? You can also change frequency by changing the capacitance of the circuit. Place the 0.1μF capacitor (C2) on top of the 0.02μF capacitor (C1); notice how the sound has changed.

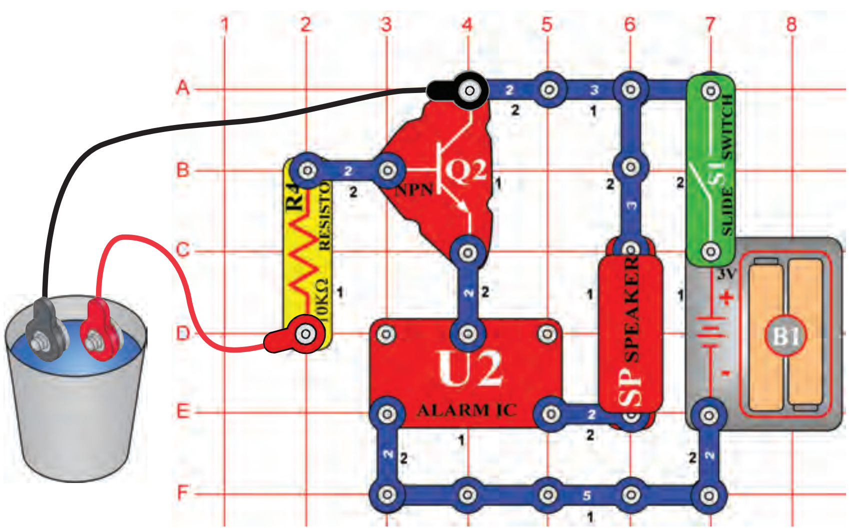
☐ Project 201 Pitch (III)

OBJECTIVE: See project #199.

Remove the 0.1μF (C2) capacitor and replace the 100kΩ resistor (R5) wth the photoresistor (RP). Wave your hand up and down over the photoresistor to change the sound. Changing the light on the photoresistor changes the circuit resistance just like varying the adjustable resistance does. **Note:** If you have the adjustable resistor (RV) set to the right and light shining on the photoresistor, then you may not get any sound because the total resistance is too low for the circuit to operate.

☐ Project #202 Flooding Alarm

OBJECTIVE: To sound an alarm when water is detected.



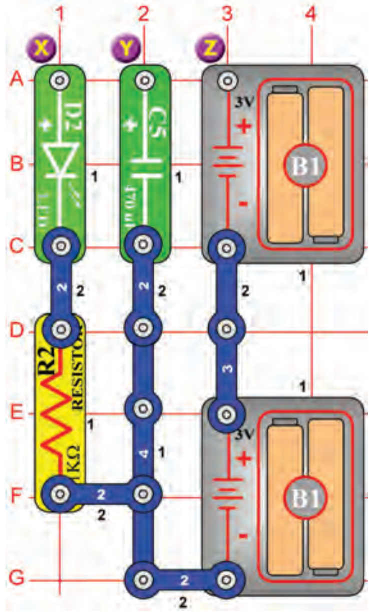
Build the circuit on the left and connect the two (2) jumpers to it, place the loose ends of the jumpers into an empty cup (without them touching each other). Turn on the slide switch (S1) - nothing happens. This circuit is designed to detect water and there is none in the cup. Add some water to the cup - an alarm sounds!

You can use longer jumper wires and hang them near your basement floor or next to your sump pump to give a warning if your basement is being flooded. Note that if the loose jumper ends accidentally touch then you will have a false alarm.

☐ Project #203

Make Your Own Battery

OBJECTIVE: To demonstrate how batteries can store electricity.



Build the circuit, then connect points Y & Z (use a 2-snap wire) for a moment. Nothing appears to happen, but you just filled up the 470μF capacitor (C5) with electricity. Now disconnect Y & Z and instead touch a connection between X & Y. The green LED (D2) will be lit and then go out after a few seconds as the electricity you stored in it is discharged through the LED and resistor (R2).

Notice that a capacitor is not very efficient at storing electricity - compare how long the 470μF kept the LED lit for with how your batteries run all of your projects! That is because a capacitor stores electrical energy while a battery stores chemical energy.

☐ Project #204

Make Your Own Battery (II)

OBJECTIVE: To demonstrate how batteries can store electricity.

In the preceding circuit, replace the 470μF capacitor (C5) with the 100μF capacitor (C3) and repeat the test. You see that the LED (D2) goes out faster, because the 100μF capacitor does not store as much electricity as the 470μF.

☐ Project #205

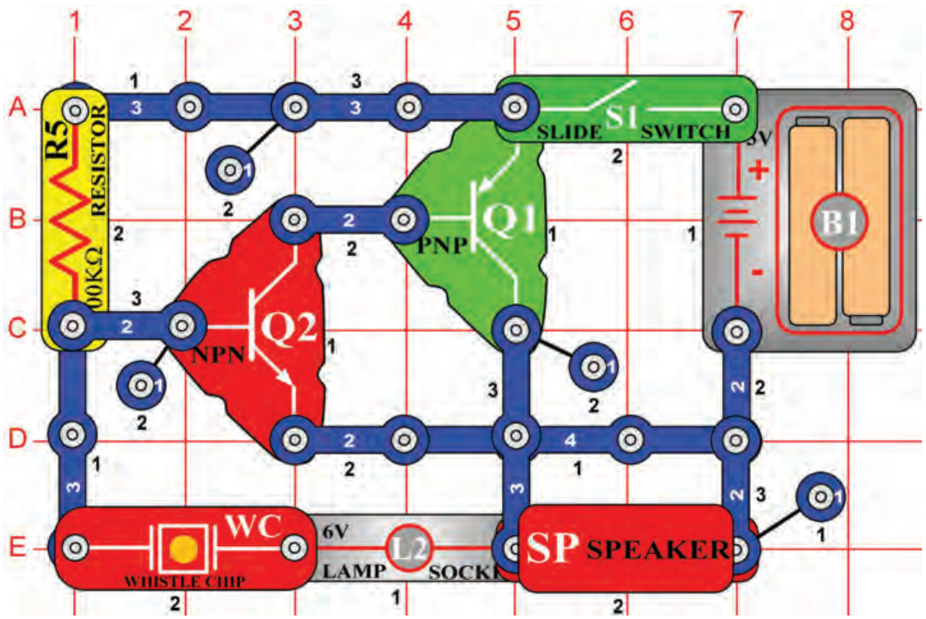
Make Your Own Battery (III)

OBJECTIVE: To demonstrate how batteries can store electricity.

Now replace the 1kΩ resistor (R2) with the 100Ω resistor (R1) and try it. The LED (D2) gets brighter but goes out faster because less resistance allows the stored electricity to dissipate faster.

☐ Project #206 Tone Generator

OBJECTIVE: To build a high-frequency oscillator.



Build the circuit and turn it on, you hear a high-frequency sound.

☐ Project #207 Tone Generator (II)

OBJECTIVE: To lower the frequency of a tone by increasing circuit capacitance.

Place the 0.02μF capacitor (C1) on top of the whistle chip (WC) in the preceding circuit, you hear a middle-frequency sound. Why? The whistle chip is used here as a capacitor and by placing the 0.02μF on top (in parallel) we have increased the capacitance, and doing so lowers the frequency.

☐ Project #208 Tone Generator (III)

OBJECTIVE: To lower the frequency of a tone by increasing circuit capacitance.

Next, replace the 0.02μF capacitor (C1) and the whistle chip (WC) with the larger 0.1μF capacitor (C2). You now hear a low frequency sound, due to yet more capacitance.

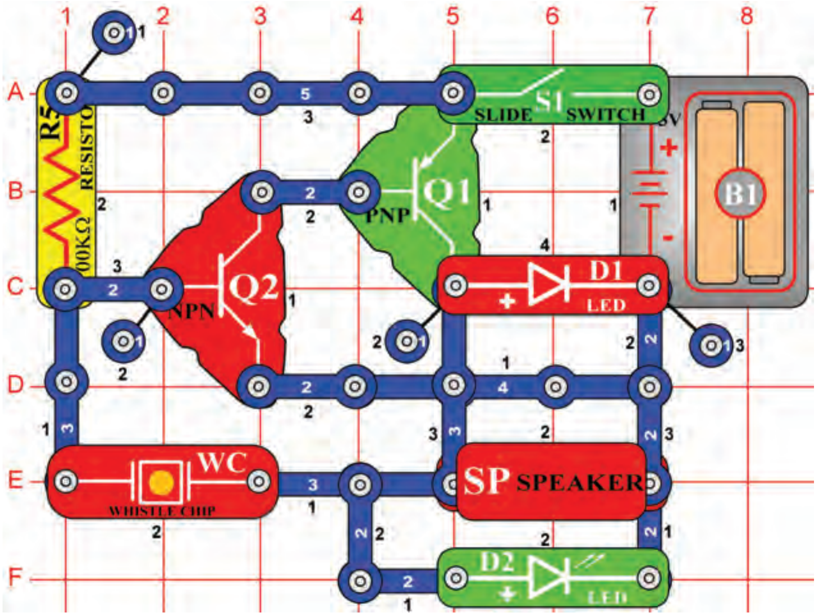
☐ Project #209 Tone Generator (IV)

OBJECTIVE: To lower the frequency of a tone by increasing circuit capacitance.

Now replace the 0.1μF (C2) with the much larger 10μF capacitor (C3), (orient with the positive (+) side towards the left); the circuit just clicks about once a second. There isn't a constant tone anymore due to other transistor properties. You need a different type of circuit to create very low frequency tones.

Project #210 — More Tone Generator

OBJECTIVE: To build a middle-frequency oscillator.



Build the circuit, as the name suggests this circuit is similar to that in project #206. Turn it on, you hear a middle-frequency sound.

Project #211 — More Tone Generator (II)

OBJECTIVE: To lower the frequency of a tone by increasing circuit capacitance.

Place the 0.02μF capacitor (C1) or the 0.1μF capacitor (C2) on top of the whistle chip (WC). The sound is different now because the added capacitance has lowered the frequency. The LED's appear to be on, but are actually blinking at a very fast rate.

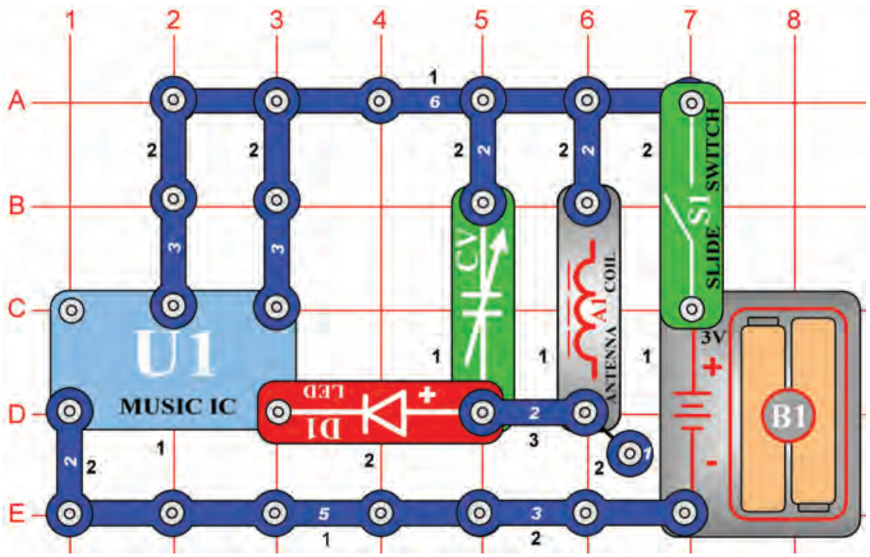
Project #212 — More Tone Generator (III)

OBJECTIVE: To lower the frequency of a tone by increasing circuit capacitance.

Now place the 10μF capacitor (C3) on top of the whistle chip (WC). You hear a clicking sound as the LED's blink about once a second.

☐ Project #213 Music Radio Station

OBJECTIVE: To create music and transmit it to a radio.



You need an AM radio for this project. Build the circuit shown on the left and turn on the slide switch (S1). Place it next to your AM radio and tune the radio frequency to where no other station is transmitting.

Then, tune the variable capacitor (CV) until your music sounds best on the radio.

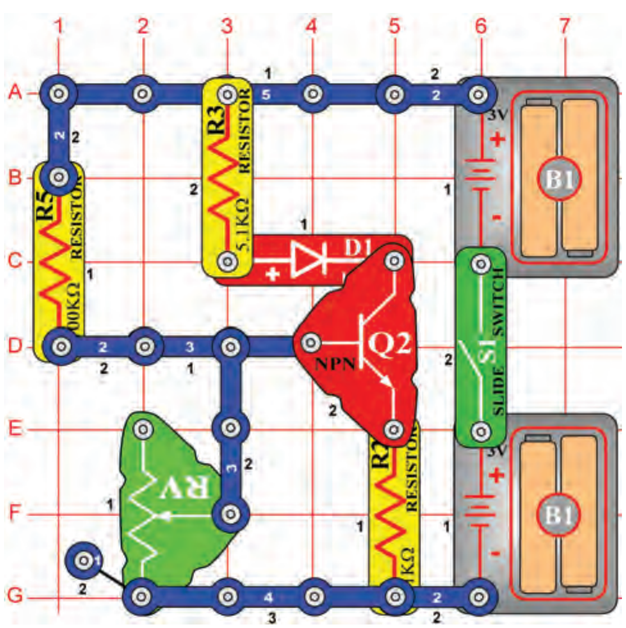
☐ Project #214 Alarm Radio Station

OBJECTIVE: To create music and transmit it to a radio.

Replace the music IC (U1) with the alarm IC (U2), and then you will hear a machine gun sound on the radio. You may need to re-tune the variable capacitor (CV).

☐ Project #215 Standard Transistor Circuit

OBJECTIVE: To save some electricity for later use.



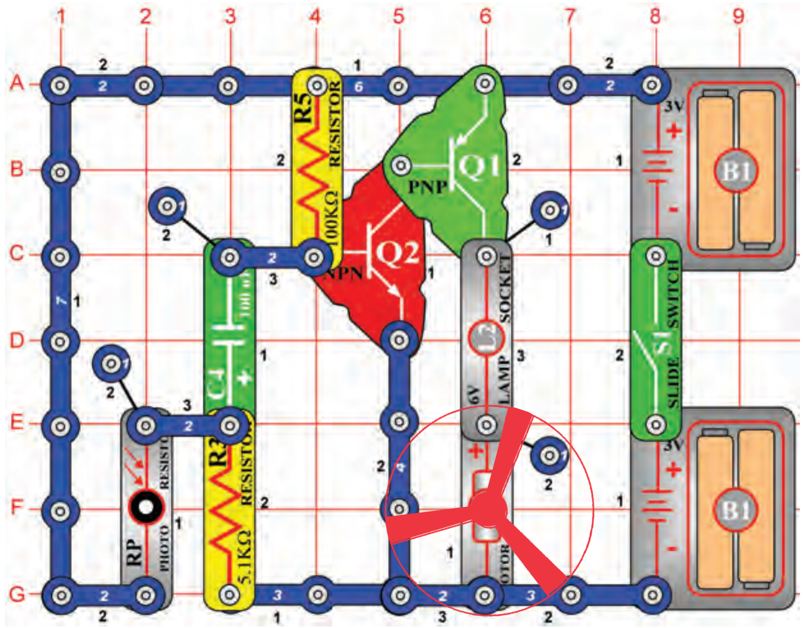
Turn on the slide switch (S1) and move the adjustable resistor (RV) control lever across its range. When the lever is all the way down the LED (D1) will be off, as you move the lever up it will come on and reach full brightness.

This circuit is considered the standard transistor configuration for amplifiers. The adjustable resistor control will normally be set so that the LED is at half brightness, since this minimizes distortion of the signal being amplified.

Project #216

Motor & Lamp by Sound

OBJECTIVE: To control a motor using light.



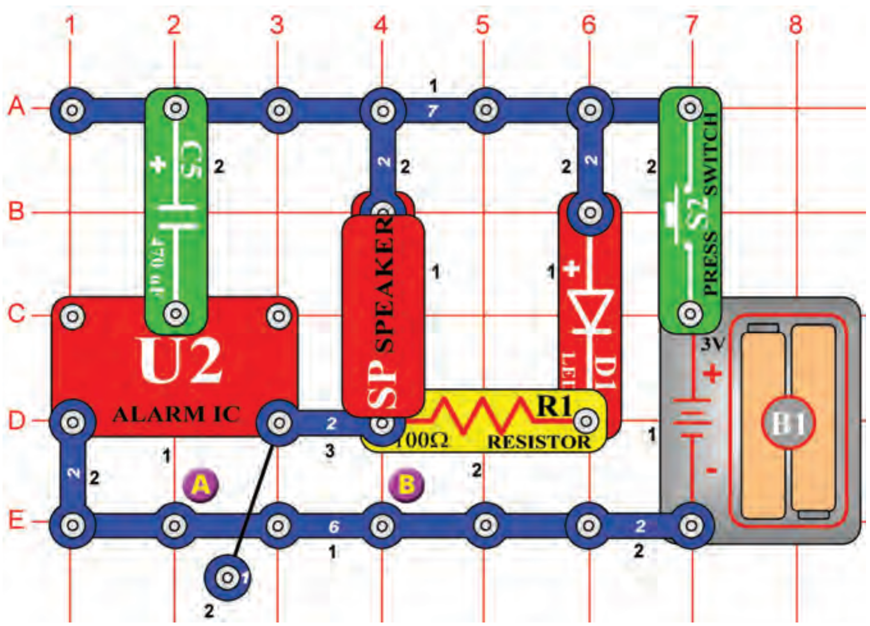
Turn the slide switch (S1) on, the motor (M1) spins and the lamp (L2) lights. As you move your hand over the photoresistor (RP), the motor slows. Now place finger onto the photoresistor to block the light. The motor slows down. In a few seconds, the motor speeds up again.

WARNING: Moving parts. Do not touch the fan or motor during operation. Do not lean over the motor.

Project #217

Fading Siren

OBJECTIVE: To produce sound of a siren driving away into the distance.



Press the press switch (S2), the alarm IC (U2) should make the sound of an up-down siren that gets weaker with time. The fading is produced by the charging of the 470μF capacitor (C5). After it is charged the current stops and the sound is very weak.

To repeat this effect you must release the press switch, remove the capacitor, and discharge it by placing it across the snaps on the bottom bar marked A & B. Then, replace the capacitor and press the switch again.

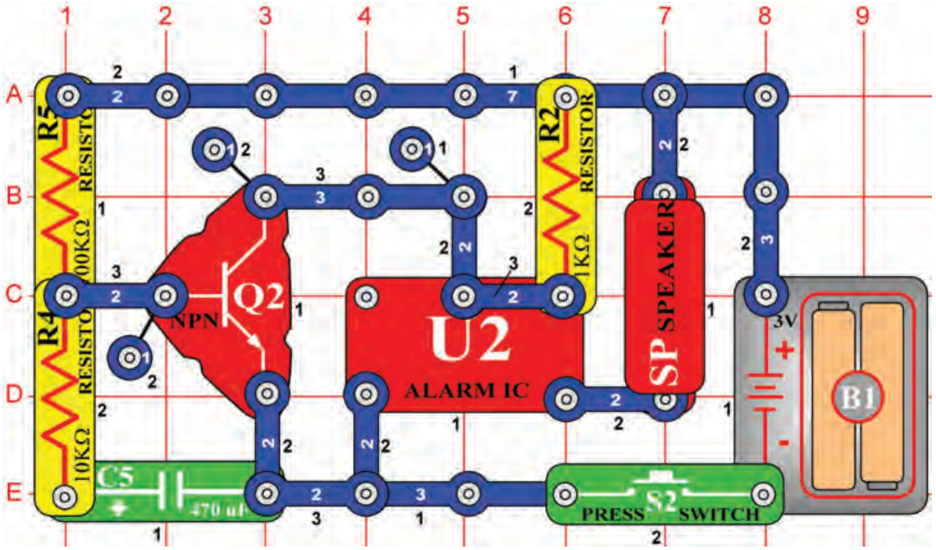
Project #218

Fast Fade Siren

OBJECTIVE: To produce sound of a siren driving away into the distance.

Replace the 470μF capacitor (C5) with the 100μF capacitor (C4), the siren fades faster.

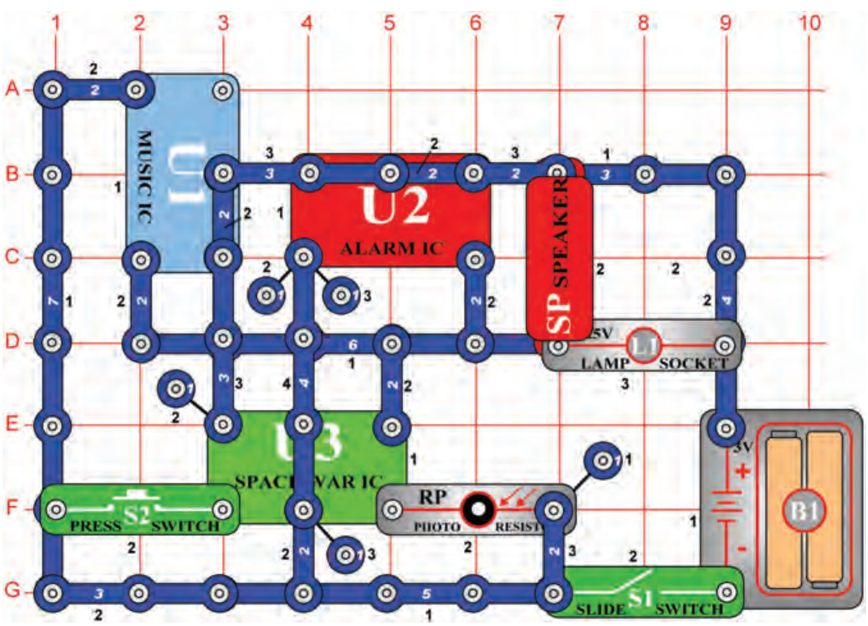
Project #219 Laser Gun with Limited Shots



OBJECTIVE: To build a circuit with laser gun sounds and a limited amount of shots.

When you press the press switch (S2), the alarm IC (U2) should start sounding a very loud laser gun sound. The speaker (SP) will sound, simulating a burst of laser energy. You can shoot long repeating laser burst, or short zaps by tapping the trigger switch. But be careful, this gun will run out of energy and you will have to wait for the energy pack (C5) to recharge. This type of gun is more like a real life laser gun because power would run out after a few shots due to energy drain. In a real laser, the energy pack would have to be replaced. Here you only have to wait a few seconds for recharge.

Project #220 Symphony of Sounds



OBJECTIVE: To combine sounds from the music, alarm, and space war integrated circuits.

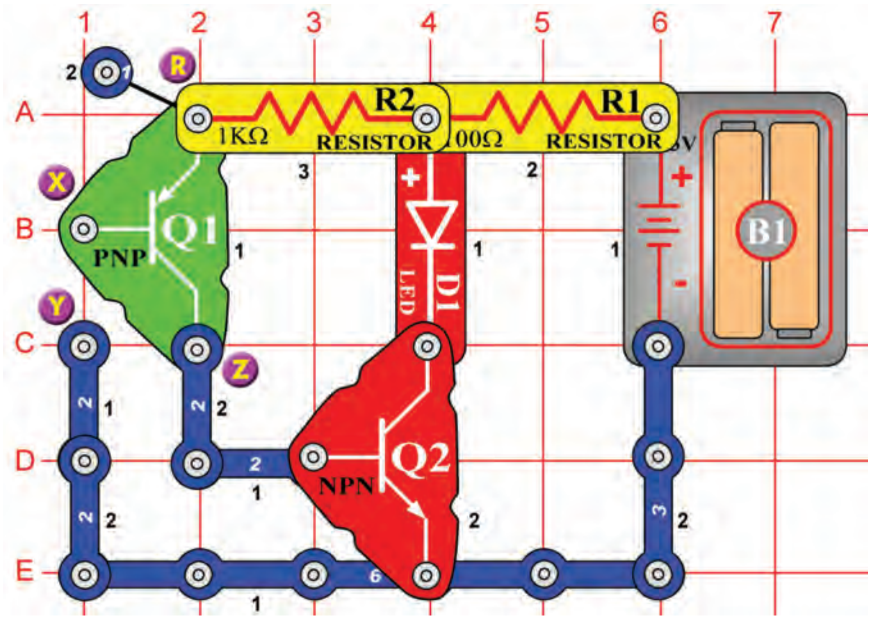
Build the circuit shown. Turn it on and press the press switch (S2) several times and wave your hand over the photoresistor (RP) to hear the full symphony of sounds that this circuit can create. Have fun!

Project #221 Symphony of Sounds (II)

OBJECTIVE: See project #220.

The preceding circuit may be too loud, so replace the speaker (SP) with the whistle chip (WC).

Project #222 Transistor Amplifiers



OBJECTIVE: To learn about the most important component in electronics.

When you place one or more fingers across the two snaps marked X & Y you will notice the LED (D1) turns on. The two transistors are being used to amplify the very tiny current going through your body to turn on the LED. Transistors are actually electrical current amplifiers. The PNP transistor (Q1) has the arrow pointing into the transistor body. The NPN transistor (Q2) has the arrow pointing out of the transistor body. The PNP amplifies the current from your fingers first, then the NPN amplifies it more to turn on the LED.

Project #223 Pressure Meter

OBJECTIVE: To show how electronic amplifiers can detect skin pressure on two contacts.

Use the circuit from project #222 shown above.

When you placed your fingers across the two snaps marked X & Y you noticed the LED (D1) came on in project #222. Repeat this process, but this time press very lightly on the two snaps marked X & Y. Notice how the brightness of the LED is dependent on the amount of pressure you use. Pressing hard makes the LED bright while pressing very gently makes it dim or even flash. This is due to what technicians call "contact resistance". Even switches made to turn your lights on and off have some resistance in them. When large currents flow, this resistance will drop the voltage and produce the undesirable side effect of heat.

Project #224 Resistance Meter

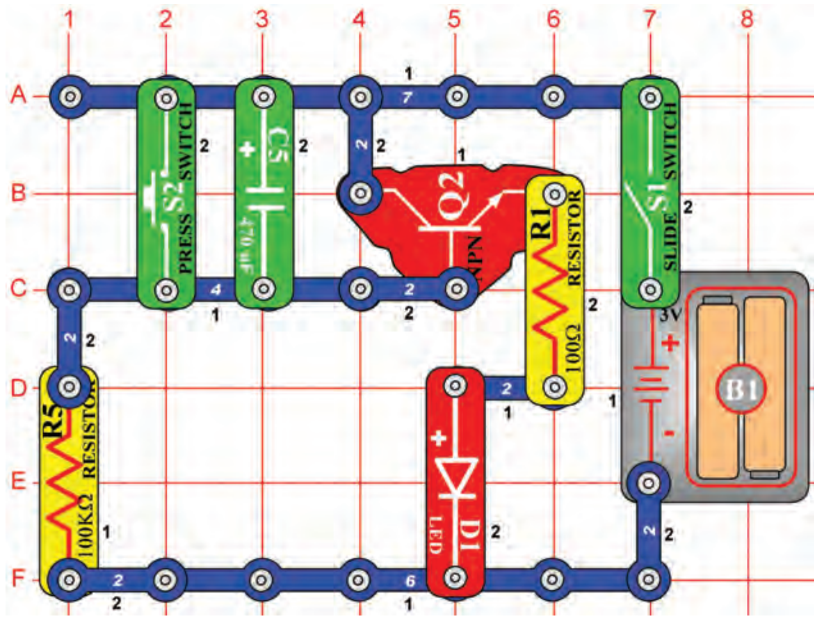
OBJECTIVE: To show how electronic amplifiers can detect different values of resistance.

Use the circuit from project #222 shown above

When you placed your fingers across the two snaps marked X & Y you noticed the LED (D1) came on in project #222. In this project, you will place different resistors across R & Z and see how bright the LED glows. Do not snap them in; just press them up against the snaps labeled R & Z in the diagram above.
First, place the 100kΩ resistor (R5) across the R & Z snaps and note the brightness of the LED. Next, press the 5.1kΩ resistor (R3) across R & Z. Notice how the LED gets brighter when the resistance is less. This is because the NPN amplifier (Q2) gets more current at its input when the resistance is lower. The PNP amplifier (Q1) is not used in this test.

Project #225 Auto-Off Night-Light

OBJECTIVE: To learn about one device that is used to delay actions in electronics.



When you turn on the slide switch (S1) the first time the LED (D1) will come on and very slowly get dimmer and dimmer. If you turn the slide switch (S1) off and back on after the light goes out it will NOT come on again. The 470μF capacitor (C5) has charged up and the NPN transistor amplifier (Q2) can get no current at its input to turn it on.

This circuit would make a good night-light. It would allow you to get into bed, and then it would go out. No further current is taken from the battery so it will not drain the batteries (B1) even if left on all night.

Project #226 Discharging Caps

OBJECTIVE: To show how capacitor delays can be repeated by discharging the capacitor.

Use the circuit from project #225 shown above.

When you first turned on the slide switch (S1) in project #225, the LED (D1) came on and very slowly got dimmer and dimmer. When you turned the slide switch (S1) off and back on after the light went out, it did NOT come on again. The 470μF capacitor (C5) was charged and everything stopped. This time turn the slide switch off. Then press the press switch (S2) for a moment to discharge the 470μF capacitor. Now when you turn the slide switch back on the delay repeats. Shorting a capacitor with a low resistance will allow the charges on the capacitor to leave through the resistance. In this case, the low resistance was the press switch.

Project #227 Changing Delay Time

OBJECTIVE: To show how the size of the capacitor effects the delay time.

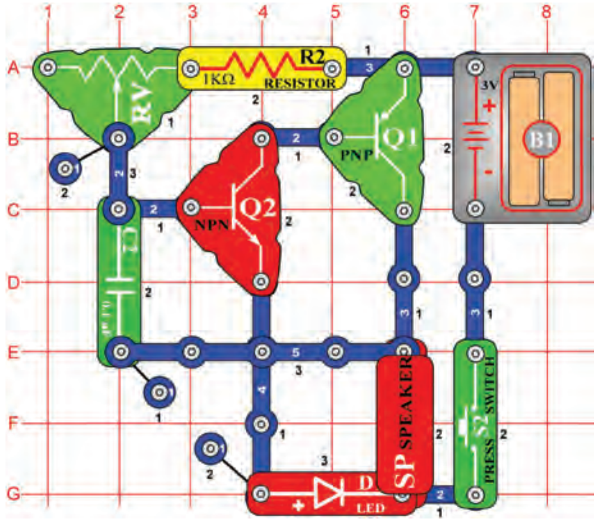
Use the circuit from project #225 shown above.

Change the 470μF capacitor (C5) to the 100μF capacitor (C4). Make sure the capacitor (C4) is fully discharged by pressing the press switch (S2) before closing the on-off slide switch (S1). When slide switch is turned on, notice how much quicker the LED (D1) goes out. Since 100μF is approximately 5 times smaller than 470μF, the LED will go out 5 times faster. The bigger the capacitor the longer the delay.

In electronics, capacitors are used in every piece of equipment to delay signal or tune circuits to a desired frequency.

☐ Project #228 Morse Code Generator

OBJECTIVE: To make a Morse code generator and learn to generate code.



When you press down on the press switch (S2) you will hear a tone. By pressing and releasing the press switch you can generate long and short tones called Morse code. For International code, a short tone is represented by a "+", and a long tone by a "–". See the chart below for letter or number followed by code.

A +–	G ––+	M ––	S +++	Y –+––	5 +++++
B –+++	H ++++	N –+	T –	Z ––++	6 –++++
C –+–+	I ++	O –––	U ++–	1 +––––	7 ––+++
D –++	J +–––	P +––+	V +++–	2 ++–––	8 –––++
E +	K –+–	Q ––+–	W +––	3 +++––	9 ––––+
F ++–+	L +–++	R +–+	X –++–	4 ++++–	0 –––––

☐ Project #229 LED Code Teacher

OBJECTIVE: A method of learning the Morse code without all the noise.

Use the circuit from project #228 shown above. Replace the speaker with a 100Ω resistor (R1) so you can practice generating the Morse code without the loud speaker. Have someone transmit code and watch the LED. Tell them the letter or number after each is generated. When you have learned code, replace the speaker.

☐ Project #230 Ghost Shriek Machine

OBJECTIVE: To make a ghost like special effect from the Morse code generator.

Use the circuit from project #228 shown above, but change the 1kΩ resistor (R2) to a 10kΩ resistor (R4), and 0.1μF capacitor (C2) to the whistle chip (WC). While holding the press switch (S2) down, adjust both the adjustable resistor (RV) and the whistle chip for a ghost like sound. At certain settings, sound may stop or get very faint.

☐ Project #231 LED & Speaker

OBJECTIVE: To improve Morse code skills and visual recognition.

Use the circuit from project #228 shown above. Try and find a person that already knows the Morse code to send you a message with both sound and LED flashing. Try in a dark room first so LED (D1) is easier to see. Morse code is still used by many amateur radio operators to send messages around the world.

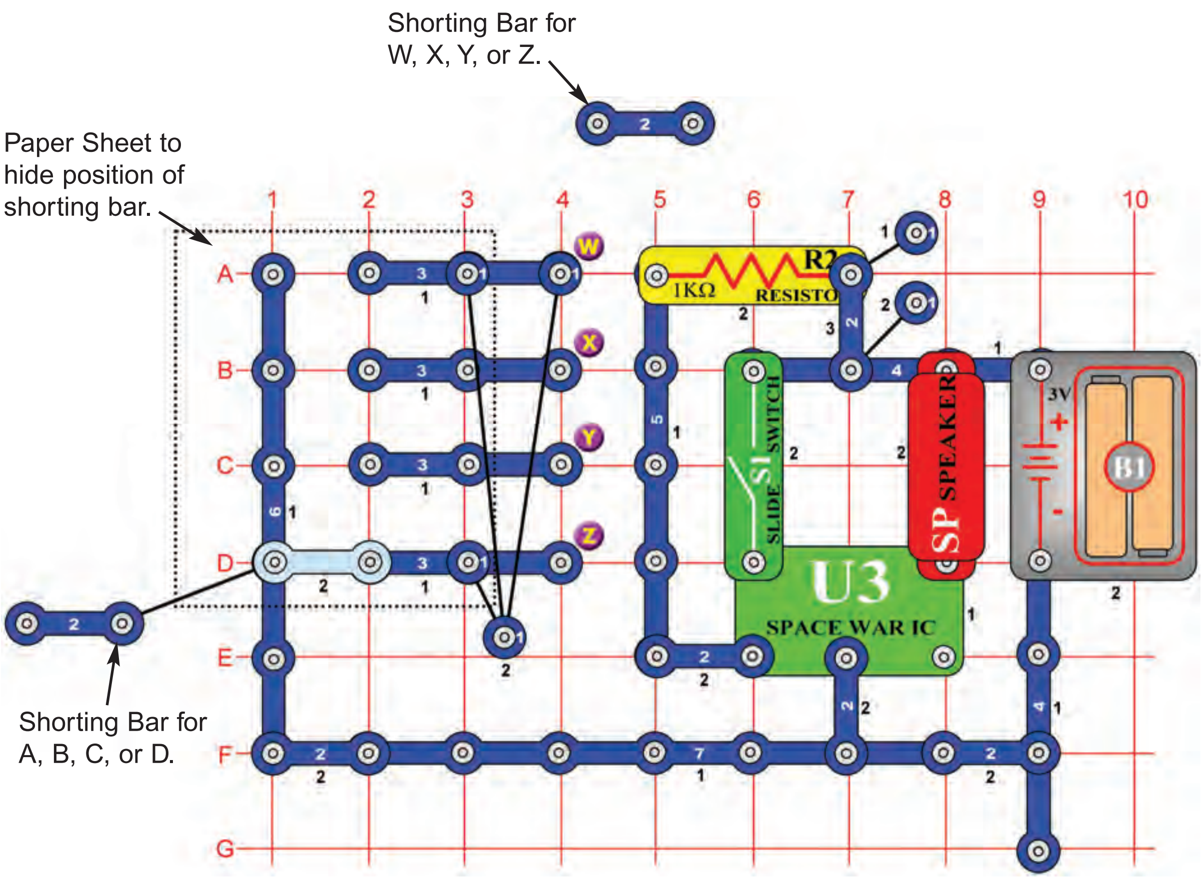
☐ Project #232 Dog Whistle

OBJECTIVE: To make an oscillator that only a dog can hear.

Use the circuit from project #228 shown above, but change the 1kΩ resistor (R2) to the 100Ω resistor (R1). While holding down the press switch (S2), move the slider on the adjustable resistor (RV) around. When the slider is near the 100Ω resistor you won't hear any sound, but the circuit is still working. This oscillator circuit is making sound waves at a frequency too high for your ears to hear. But your dog may hear it, because dogs can hear higher frequencies than people can.

☐ Project #233 — Mind Reading Game

OBJECTIVE: To make an electronic game of mind reading.



Build the circuit shown on the left. It uses two (2) 2-snap wires as shorting bars.

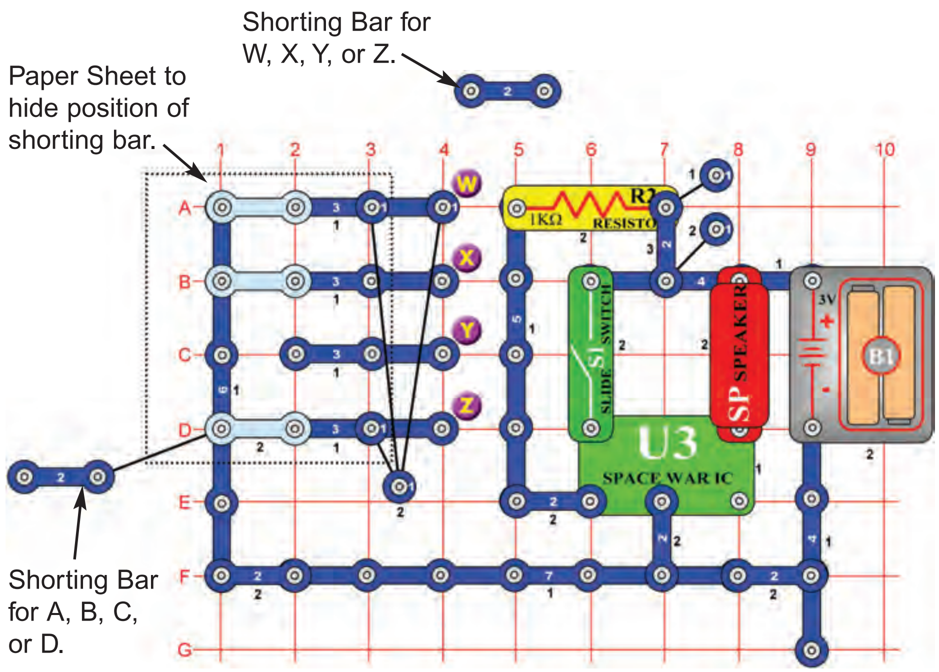
Setup: Player 1 sets up by placing one shorting bar under the paper on row A, B, C, or D. Player 2 must **NOT** know where the shorting bar is located under the paper.

The object is for Player 2 to guess the location by placing his shorting bar at positions W, X, Y, or Z. In the drawing on the left, Player 1 set up at position "D". If Player 2 places his shorting bar across "Z" on the first try, then he guessed correctly and marks a 1 on the score card sheet under that round number. If it takes three tries, then he gets a three.
Player 2 then sets the A, B, C, D side and Player 1 tries his luck. Each player records his score for each round. When all 18 rounds have been played, the player with the lowest score wins. Additional players can play. Use the score card below to determine the winner.

Round #	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	Total
Player 1	__	__	__	__	__	__	__	__	__	__	__	__	__	__	__	__	__	__	_____
Player 2	__	__	__	__	__	__	__	__	__	__	__	__	__	__	__	__	__	__	_____
Player 3	__	__	__	__	__	__	__	__	__	__	__	__	__	__	__	__	__	__	_____
Player 4	__	__	__	__	__	__	__	__	__	__	__	__	__	__	__	__	__	__	_____

Project #234 Enhanced Quiet Zone Game

OBJECTIVE: Make and play the electronic game of "Quiet Zone".



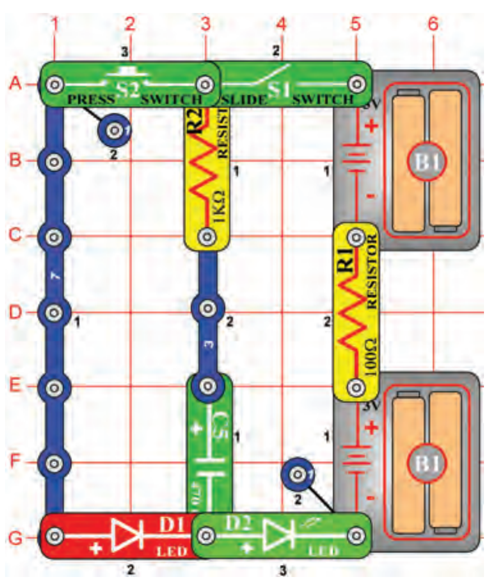
Use the circuit from project #233, but place three (3) 2-snap wires ("shorting bars") under paper as shown on left.

Setup: Player 1 sets the "Quiet Zone" by placing three (3) shorting bars under the paper on row A, B, C, or D, leaving only one open. Player 2 must **NOT** know where the shorting bars are located under the paper.

Both Player 1 and Player 2 are given 10 points. The object is for Player 2 to guess the location of the "Quiet Zone" by placing his shorting bar at positions W, X, Y, or Z. In the drawing on the left Player 1 set up the "Quiet Zone" at position "C". If Player 2 places his shorting bar across "Z" on the first try, the sounds played mean he has not found the "Quiet Zone" and he loses 1 point. He has 3 tries to find the zone on each turn. Each time sounds are made he loses a point.
Player 2 then sets the A, B, C, D side and Player 1 starts searching. Play continues until one player is at zero points and makes sound during that players turn.

Project #235 Capacitor Charge & Discharge

OBJECTIVE: To show how capacitors store and release electrical charge.



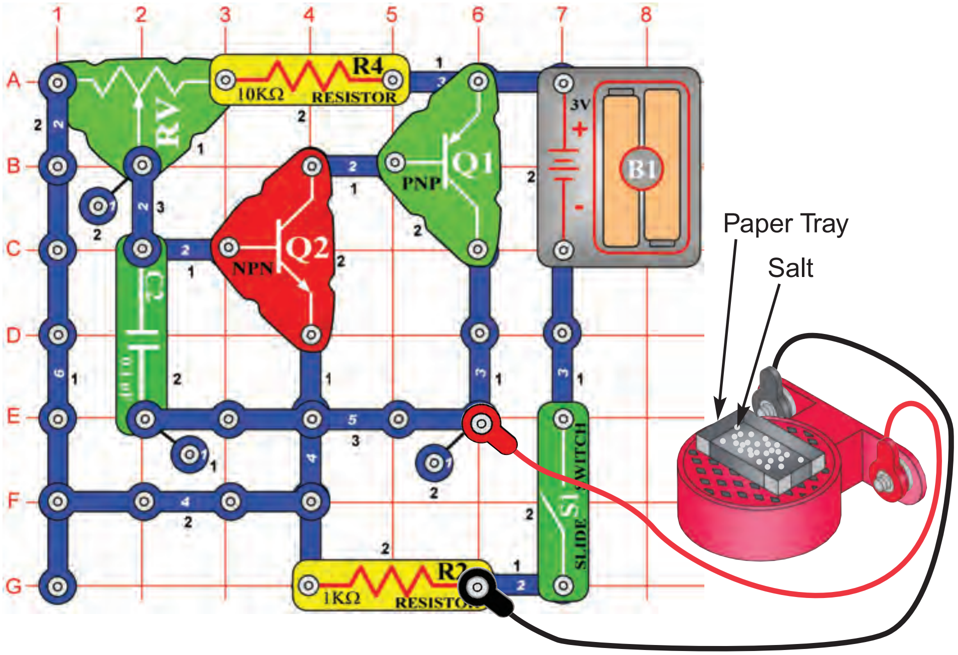
Turn on the slide switch (S1) for a few seconds, then turn it off. The green LED (D2) is initially bright but goes dim as the batteries (B1) charge up the 470μF capacitor (C5). The capacitor is storing electrical charge.

Now press the press switch (S2) for a few seconds. The red LED (D1) is initially bright but goes dim as the capacitor discharges itself through it.

The capacitor value (470μF) sets how much charge can be stored in it, and the resistor value (1kΩ) sets how quickly that charge can be stored or released.

Project #236 Sound Wave Magic

OBJECTIVE: To show how sound waves travel on a paper surface.

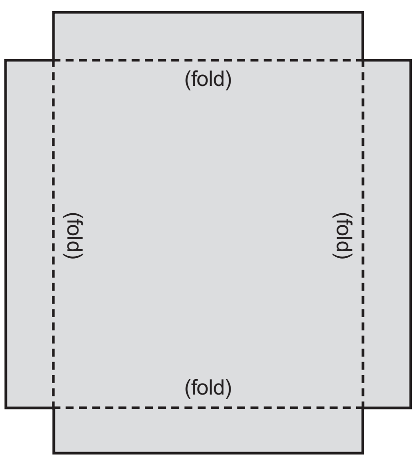


Build the circuit shown on the left and connect the speaker (SP) using the two (2) jumper wires. Then, lay the speaker on a flat hard surface.

Setup: Use some paper and scissors to cut out a rectangular pattern. Use the one shown below as a guide. Use colored paper if available. Fold at the points shown. Scotch tape the corners so the tray has no cracks at the corners. Place the tray over the speaker and sprinkle a small amount of white table salt in the tray. There should be enough salt to cover the bottom with a little space between each salt grain.

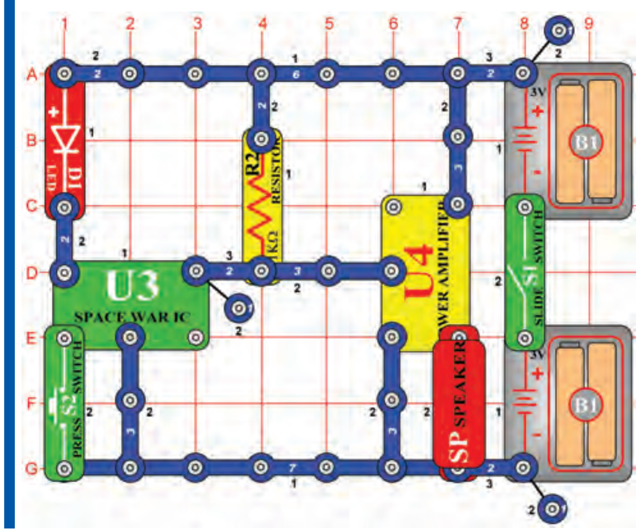
Sound Magic: Turn on the circuit by turning on the slide switch (S1). Adjust the adjustable resistor (RV) for different pitches and watch the salt particles. Particles that bounce high are directly over the vibrating paper and ones that do not move are in the nodes where the paper is not vibrating. Eventually, all the salt will move to the areas that have no vibration, and stay there.
Change the position of the tray and the material used to create different patterns due to the sound. Try sugar and coffee creamer, for example, to see if they move differently due to the sound waves.

Sample Cut-out Pattern

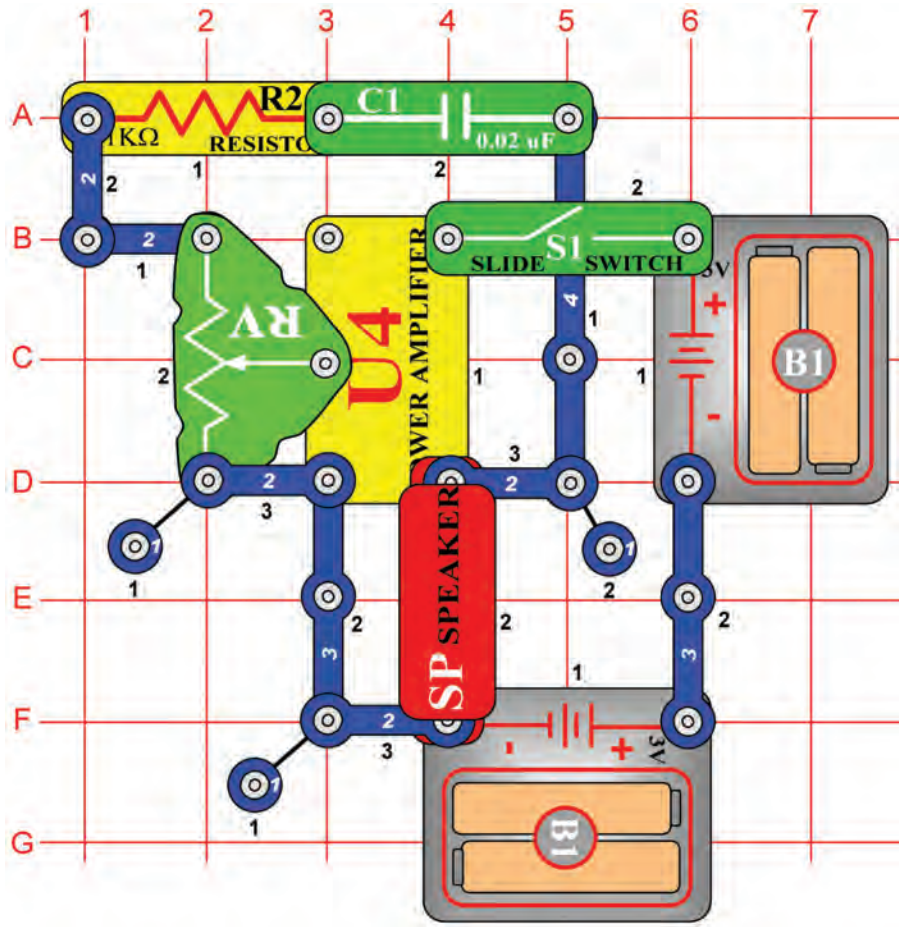


Project #237 Space War Amplifier

OBJECTIVE: To amplify sounds from the space war integrated circuit.



Build the circuit, turn on the slide switch (S1), and press the press switch (S2) several times. You will hear loud space war sounds, since the sound from the space war IC (U3) is amplified by the power amplifier IC (U4). Nearly all toys that make sound use a power amplifier of some sort.



Project #238
Trombone

OBJECTIVE: To build an electronic trombone that changes pitch of note with slider bar.

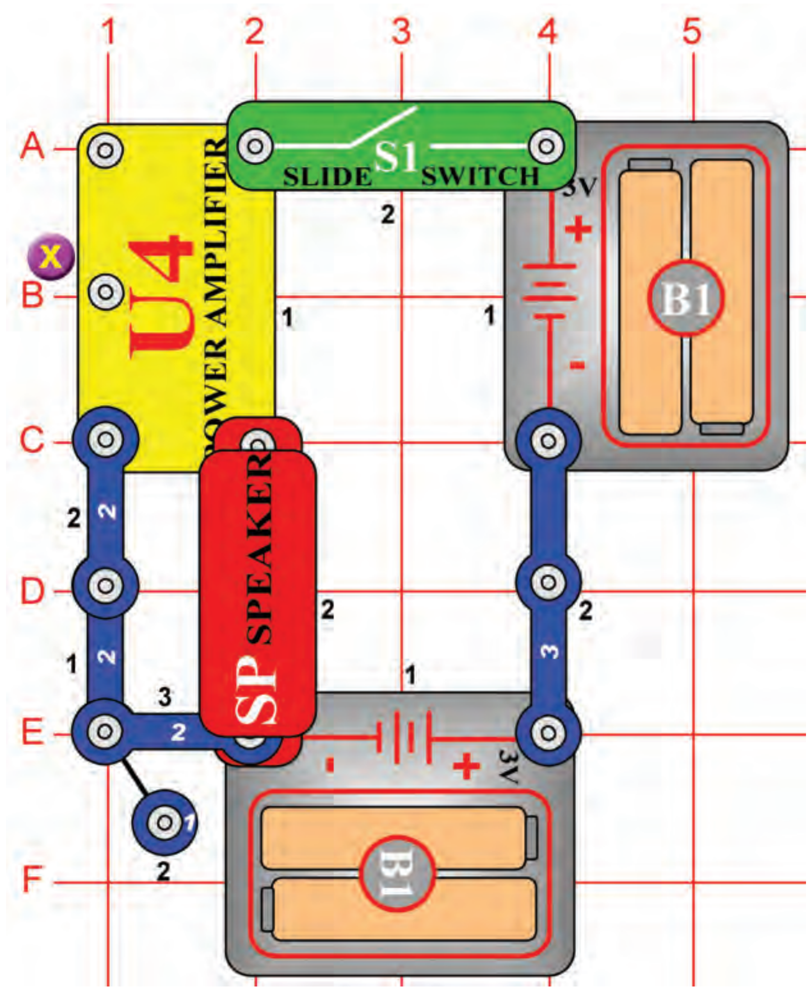
When you turn on the slide switch (S1) the trombone should start playing. To change the pitch of the note, simply slide the adjustable resistor (RV) control back and forth. By turning the slide switch on and off and moving the slider, you will be able to play a song much like a trombone player makes music. The switch represents air going through the trombone, and the adjustable resistor control is the same as a trombone slider bar. The circuit may be silent at some positions of the resistor control.

Project #239
Race Car Engine

OBJECTIVE: To show how changing frequency changes the sound to a different special effect.

Use the circuit from project #238 shown on the left, but change the 0.02μF capacitor (C1) to a 10μF capacitor (C3). Make sure the positive (+) mark on the capacitor is **NOT** on the resistor (R2) side when you snap it in.

When the slide switch (S1) is turned on, you should hear a very low frequency oscillation. By sliding the adjustable resistor (RV) control up and down, you should be able to make the sound of a race car engine as it's motor speeds up and slows down.



Project #240

Power Amplifier

OBJECTIVE: To check stability of power amplifier with open input.

When you turn on the slide switch (S1), the power amplifier IC (U4) should not oscillate. You should be able to touch point X with your finger and hear static. If you do not hear anything, listen closely and wet your finger that touches point X. High frequency clicks or static should be coming from speaker (SP) indicating that the amplifier is powered on and ready to amplify signals.

The power amplifier may oscillate on its own. Do not worry, this is normal with high gain high-powered amplifiers.

Project #241

Feedback Kazoo

OBJECTIVE: To show how electronic feedback can be used to make a musical instrument.

Use the circuit from project #240 shown on the left.

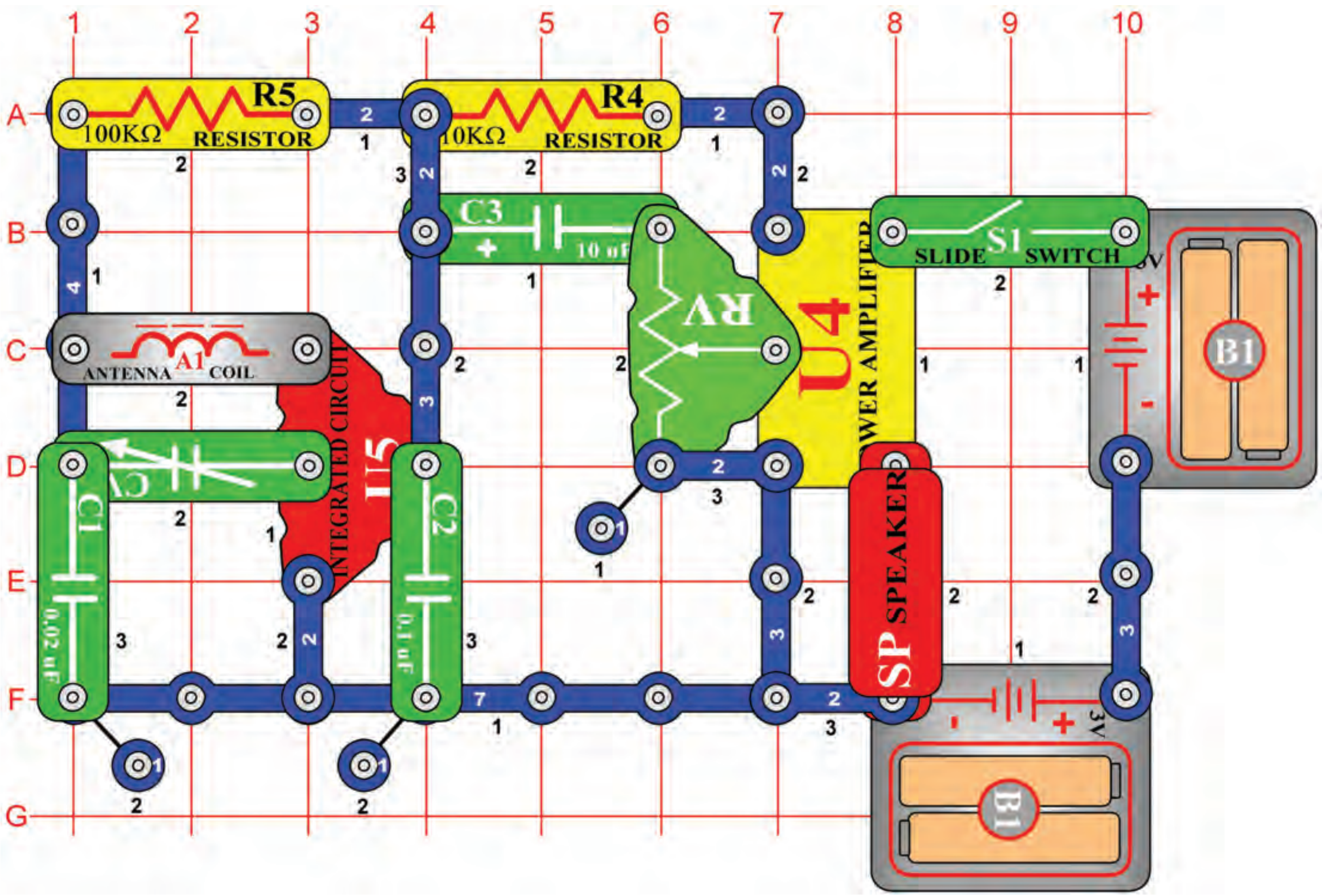
When you place one finger on point X and a finger from your other hand on the speaker (SP) snap that is not connected to the battery (B1), what happens? If the amplifier starts to oscillate it is due to the fact that you just provided a feedback path to make the amplifier into an oscillator. You may even be able to change the pitch of the oscillation by pressing harder on the snaps.

This is the principle used to make an electronic kazoo. If you practice and learn the amount of pressure required to make each note, you may even be able to play a few songs.

☐

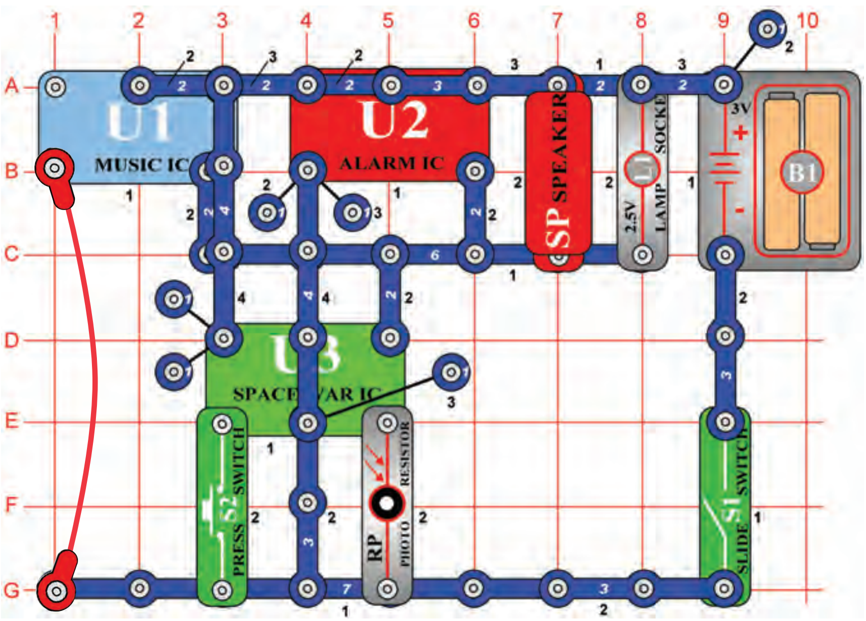
Project #242
AM Radio

OBJECTIVE: To make a complete working AM radio.



When you turn on the slide switch (S1), the integrated circuit (U5) should amplify and detect the AM radio waves all around you. The variable capacitor (CV) can be tuned to the desirable station. Varying the adjustable resistor (RV) will make the audio louder or softer. The power amplifier IC (U4) drives the speaker (SP) to complete the AM radio project.

☐ Project #243 Fire Engine Symphony



OBJECTIVE: To combine sounds from the music, alarm, and space war integrated circuits.

Build the circuit shown and add the jumper to complete it. Note that in two places two single snaps are stacked on top of each other. Also, note that there is a 2-snap wire on layer 2 that does not connect with a 4-snap wire that runs over it on layer 4 (both touch the music IC, U1). Turn it on and press the press switch (S2) several times and wave your hand over the photoresistor (RP) to hear the full spectrum of sounds that this circuit can create. Have fun!

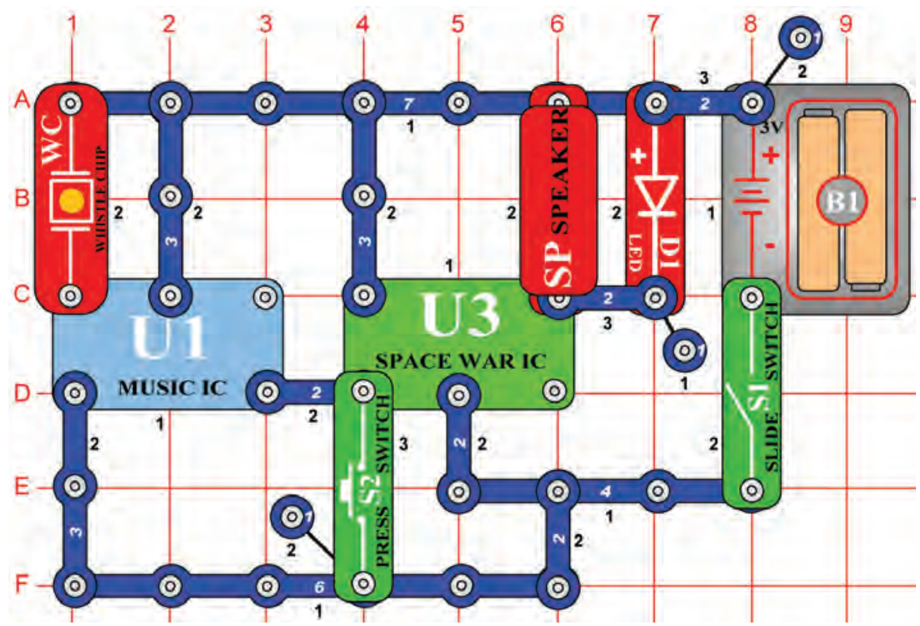
☐ Project #244 Fire Engine Symphony (II)

OBJECTIVE: See project #243.

The preceding circuit may be too loud, so replace the speaker (SP) with the whistle chip (WC).

Can you guess why the jumper is used in this circuit? It is being used as just a 6-snap wire, because without it you don't have enough parts to build this complex circuit.

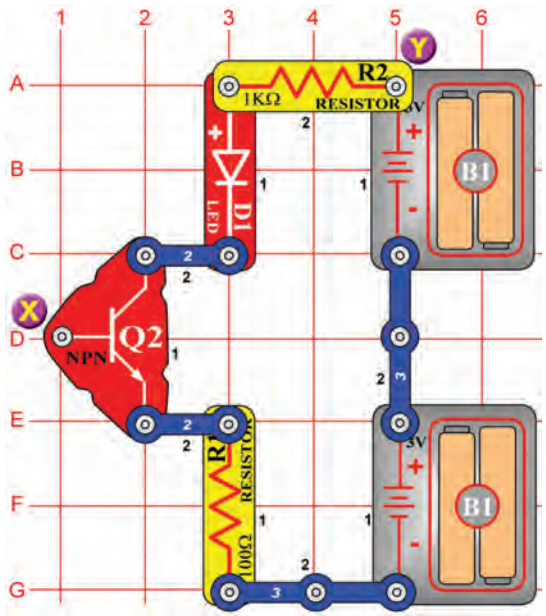
☐ Project #245 Vibration or Sound Indicator



OBJECTIVE: To build a circuit that is activated by vibration or sound.

Turn on the slide switch (S1), the war sounds start playing and the LED (D1) flashes. When all of the sounds are played, the circuit stops. Clap your hands next to the whistle chip (WC) or tap on it. Any loud sound or vibration causes the whistle chip to produce a small voltage, which activates the circuit. You can repeat a sound by holding down the press switch (S2) while it is playing.

Project #246 Two-Finger Touch Lamp

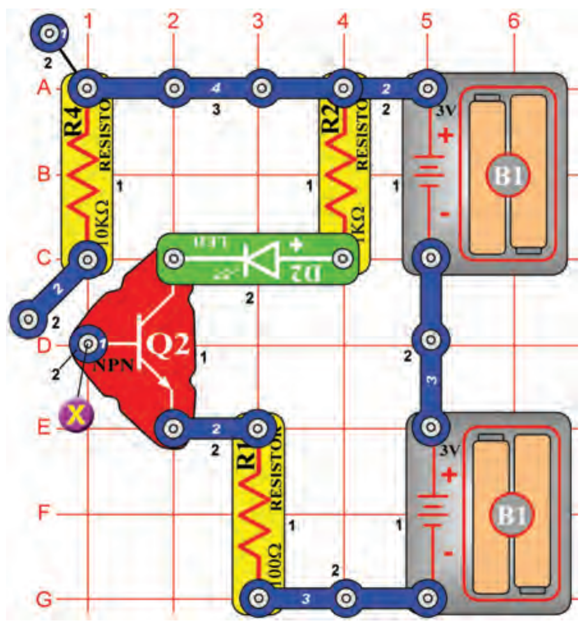


OBJECTIVE: To show that your body can be used as an electronic component.

Build the circuit on the left. You're probably wondering how it can work, since one of the points on the NPN transistor (Q2) is unconnected. It can't, but there is another component that isn't shown. That component is you.

Touch points X & Y with your fingers. The LED (D1) may be dimly lit. The problem is your fingers aren't making a good enough electrical contact with the metal. Wet your fingers with water or saliva and touch the points again. The LED should be very bright now. Think of this circuit as a touch lamp since when you touch it, the LED lights. You may have seen such a lamp in the store or already have one in your home.

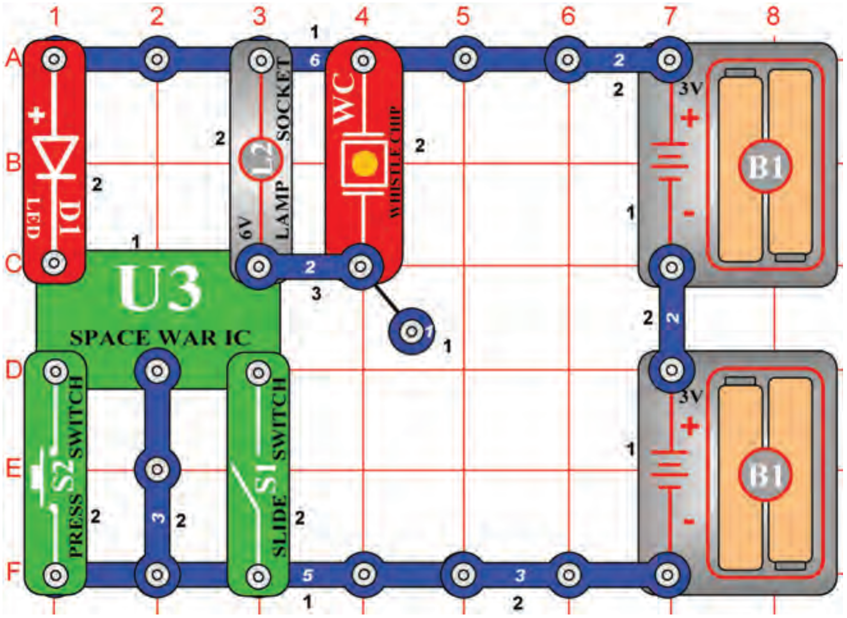
Project #247 One-Finger Touch Lamp



OBJECTIVE: To show you how finger touch lamps work.

The touch lamps you see in stores only need to be touched by one finger to light, not two. So let's see if we can improve the last circuit to only need one finger. Build the new circuit, note that near point X there is a 2-snap wire that is only mounted on one side, swing it so the plastic touches point X. Wet a large area of one of your fingers and touch it to both metal contacts at point X at the same time; the LED (D2) lights. To make it easier for one finger to touch the two contacts, touch lamps or other touch devices will have the metal contacts interweaved as shown below and will also be more sensitive so that you don't have to wet your finger to make good contact.

Project #248 Space Battle



OBJECTIVE: To make space battle sounds.

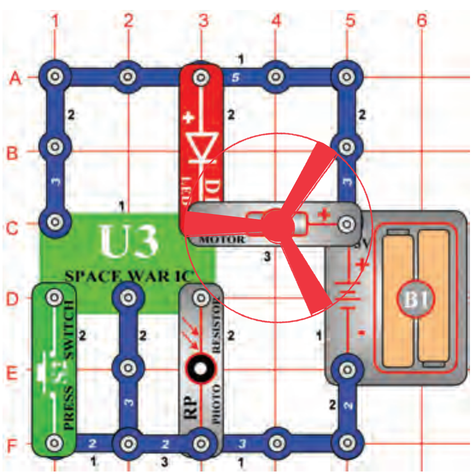
Build the circuit shown on the left. Activate the circuit by turning on the slide switch (S1) or pressing the press switch (S2), do both several times and in combination. You will hear exciting sounds and see flashing lights, as if a space battle is raging!

Project #249 Space Battle (II)

OBJECTIVE: To show how light can turn "ON" an electronic device.

Replace the slide switch (S1) with the photoresistor (RP). Now covering and uncovering the photoresistor will change the sound.

Project #250 Multi-Speed Light Fan



OBJECTIVE: To vary the speed of a fan activated by light.

Build the circuit shown on the left, with the fan on the motor (M1).

This circuit is activated by light on the photoresistor, (RP) though the fan will barely turn at all. Press the press switch (S2) and the fan will spin. If you hold the press switch down, the fan will spin faster. If you cover the photoresistor, the fan will stop unless the press switch is pressed.

WARNING: Moving parts. Do not touch the fan or motor during operation. Do not lean over the motor.

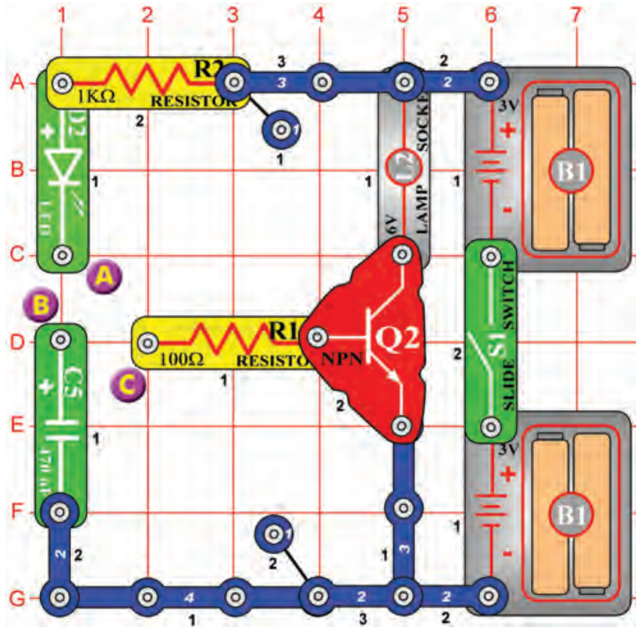
Project #251 Light & Finger Light

OBJECTIVE: To show another way the Space War IC may be used.

In the circuit at left, replace the motor (M1) with the 2.5V lamp (L1) shown below. Vary the brightness of the lamp by covering the photoresistor (RP) and holding down the press switch (S2) in various combinations. Notice that pressing the press switch when the photoresistor is covered still turns on the lamp, while in project #250, doing this would turn off the motor.

Project #252 Storing Electricity

OBJECTIVE: To store electricity in a capacitor.

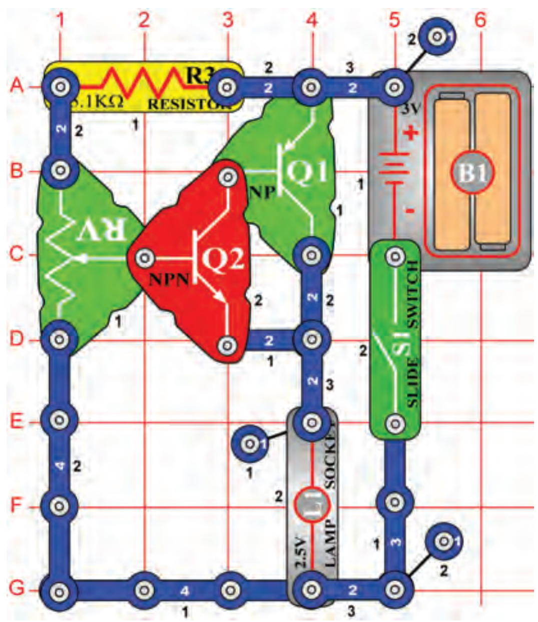


Turn the slide switch (S1) on and connect points A & B with a 2-snap wire. The green LED (D2) will flash and the 470μF capacitor (C5) will be charged with electricity. The electricity is now stored in the capacitor. Disconnect points A & B. Connect points B & C and there will be a flash from the 6V lamp (L2).

The capacitor discharges through the resistor to the base of the NPN transistor (Q2). The positive current turns on the transistor like a switch, connecting the lamp to the negative (–) side of the batteries. The light will go out after the capacitor discharges, because there is no more current at the base of the transistor.

Project #253 Lamp Brightness Control

OBJECTIVE: To use a transistor combination to control a lamp.



Here is a combination with two transistors. This combination increases the amplifying power. By changing the resistance, the current at the base of the transistor is also changed. With this amplifying ability of the combination, there is a greater change of current to the lamp (L1). This changes the brightness.

Project #254 Electric Fan

OBJECTIVE: To make an electric fan using a transistor circuit.

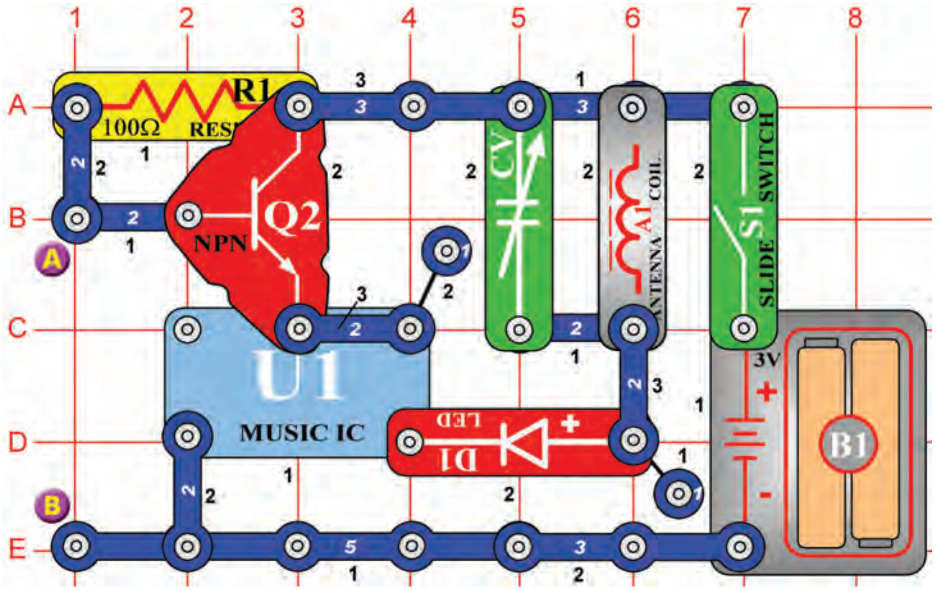
Use the circuit from project #253. Replace the lamp (L1) with the motor (M1) and install the fan. By controlling the adjustable resistor (RV), the speed of the fan changes. Now you can make your own speed changing electric fan.

WARNING: Moving parts. Do not touch the fan or motor during operation. Do not lean over the motor.

Project #255

Radio Music Burglar Alarm

OBJECTIVE: To build an alarm that plays music on the radio.



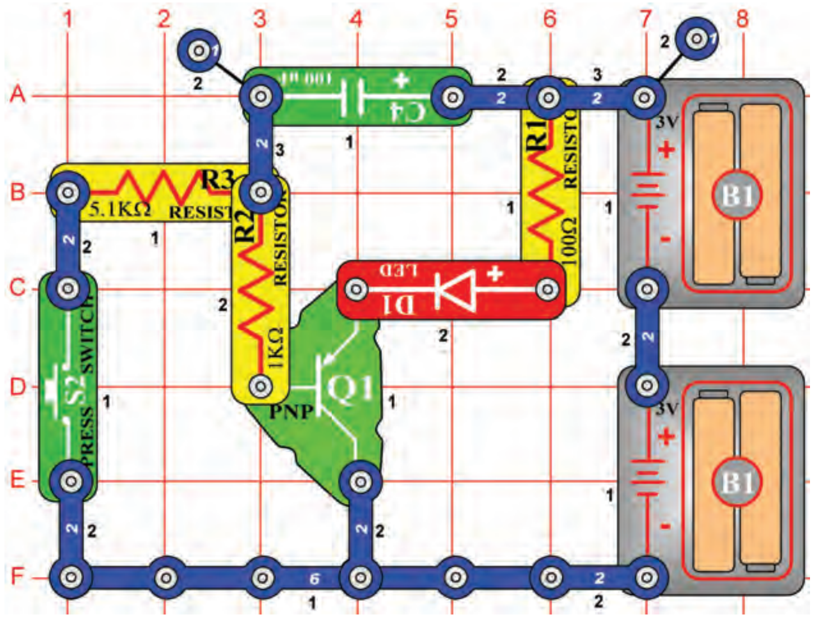
Place the circuit next to an AM radio. Tune the radio so no stations are heard. Set the slide switch (S1) on. You should hear the song play. The red LED (D1) should also be lit. Adjust the variable capacitor (CV) for the loudest signal.

Connect a jumper wire across points A & B and the music stops. The transistor (Q2) acts like a switch connecting power to the music IC (U1). Positive voltage on the base turns on the switch and negative voltage opens it. Connect a string to the jumper wire and the other end of the string to a door or window. Turn the slide switch on. If a thief comes in through the door or window, the string pulls the jumper off and the music plays on the radio.

Project #256

Light Dimmer

OBJECTIVE: To build a light dimmer.

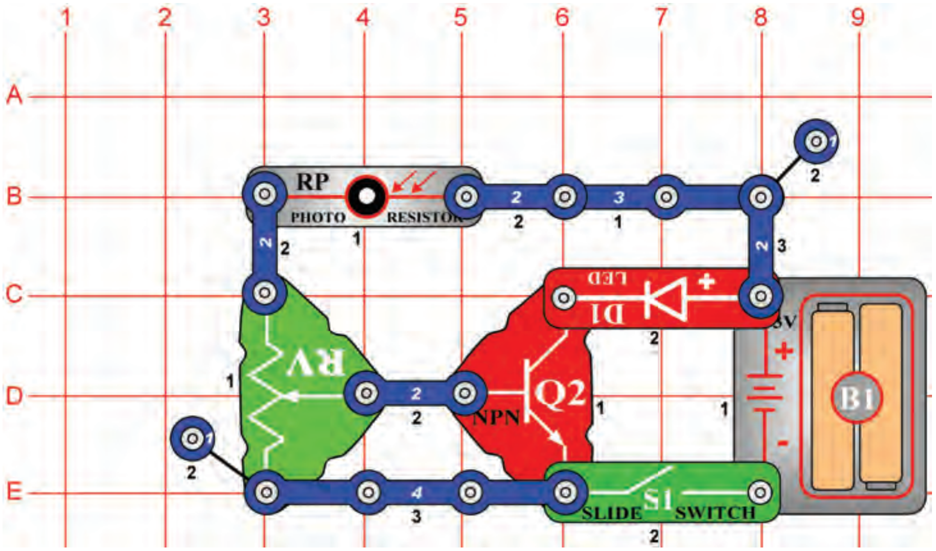


Press the press switch (S2) to complete the current's path flow. You might expect the LED (D1) to light instantly but it doesn't. The charging current flows into the 100μF capacitor (C4) first. As the capacitor charges, the charging current decreases, input current to the PNP transistor (Q1) increases. So current begins to flow to the LED and the LED gradually brightens.

Now release the press switch. The capacitor begins to discharge, sending input current to the transistor. As the capacitor discharges, the input current reduces to zero and gradually turns off the LED and the transistor.

Project #257 Motion Detector

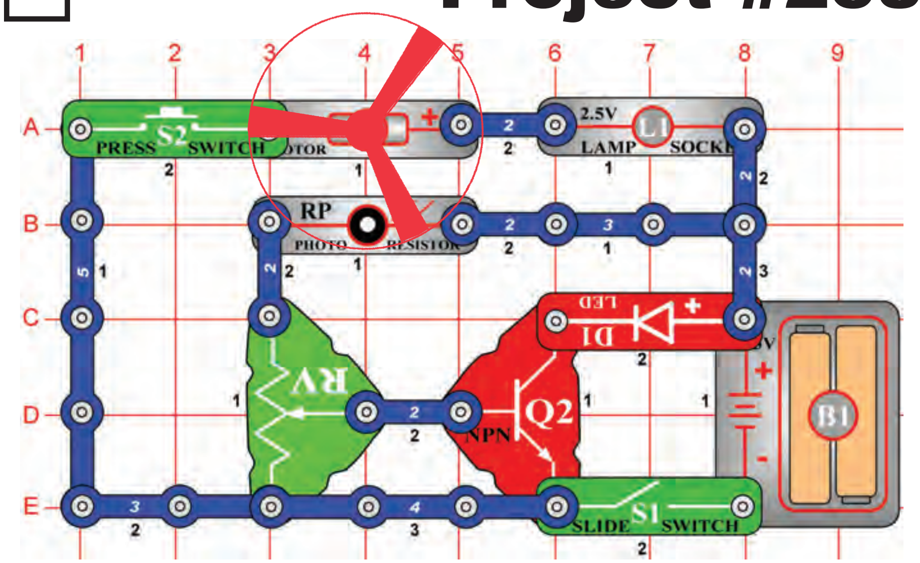
OBJECTIVE: Build a circuit that detects motion.



Set the adjustable resistor (RV) to the center position. Turn the slide switch (S1) on and the LED (D1) lights. Wave your hand over the photoresistor (RP) and the LED turns off and on. The resistance changes as the amount of light strikes the photoresistor. As the light decreases, the resistance increases. The increased resistance lowers the voltage at the base of the NPN transistor (Q2). This turns off the transistor, preventing current flowing through the LED to the negative (–) side of the battery (B1). Wave your hand over photoresistor at different distances. The LED gets brighter the farther away your hand is.

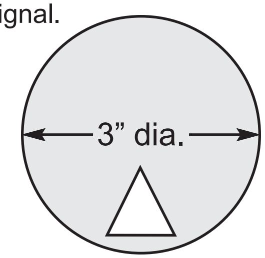
Project #258 Fan Modulator

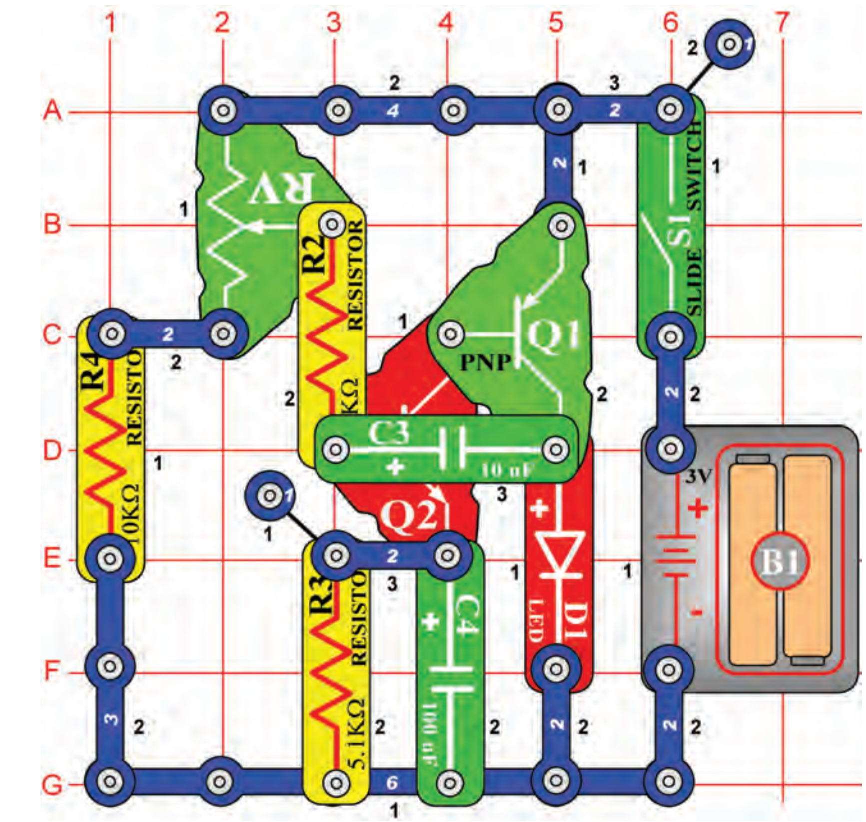
OBJECTIVE: To modulate the brightness of an LED.



WARNING: Moving parts. Do not touch the fan or motor during operation. Do not lean over the motor.

Using the fan outline as a guide, cut a 3" circle out of a piece of paper. Then, cut a small triangle in it as shown. Tape the circle onto the fan and then place it onto the motor (M1). Set the adjustable resistor (RV) to the center position and turn the slide switch (S1) on. Press the press switch (S2), the fan spins and the lamp (L1) lights. As the triangle opening moves over the photoresistor (RP), more light strikes it. The brightness of the LED changes, or is *modulated*. As in AM or FM radio, modulation uses one signal to modify the amplitude or frequency of another signal.





☐ Project #259

Oscillator 0.5 - 30Hz

OBJECTIVE: To build a 0.5Hz - 30Hz oscillator that will light an LED.

Set the adjustable resistor (RV) to the bottom position and then turn the slide switch (S1) on. The LED (D1) will start flashing at a frequency of 0.5Hz (once every two seconds). Slowly adjust the adjustable resistor and the LED flashes faster. As the frequency increases, the LED flashes faster. Eventually, the LED flashes so fast, it looks like it is on all of the time.

☐ Project #260

Sound Pulse Oscillator

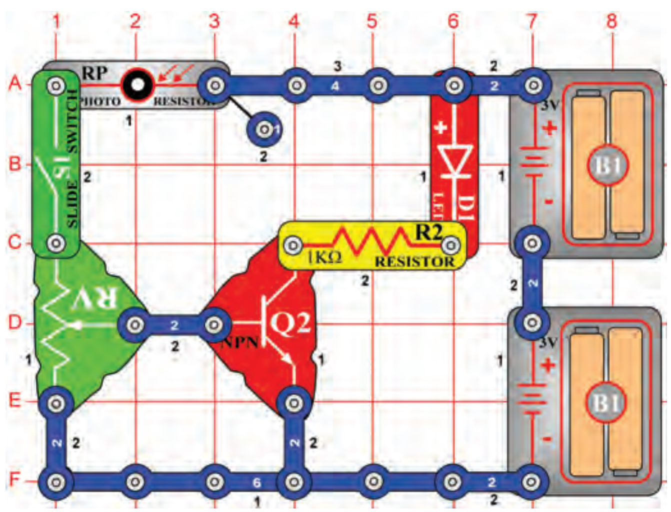
OBJECTIVE: To build a 0.5Hz - 30Hz oscillator and hear it on a speaker.

Use the circuit from project #259.
Connect a single snap under the speaker (SP) and then connect it across the LED (on level 4). Turn the slide switch (S1) on and now you can hear the oscillator. Adjust the adjustable resistor (RV) to hear the different frequencies. Now you can hear and see the frequencies. Note: You may not hear sounds at all settings of the adjustable resistor.

☐ Project #261

Motion Detector (II)

OBJECTIVE: To build a motion detector that senses an objects movement.



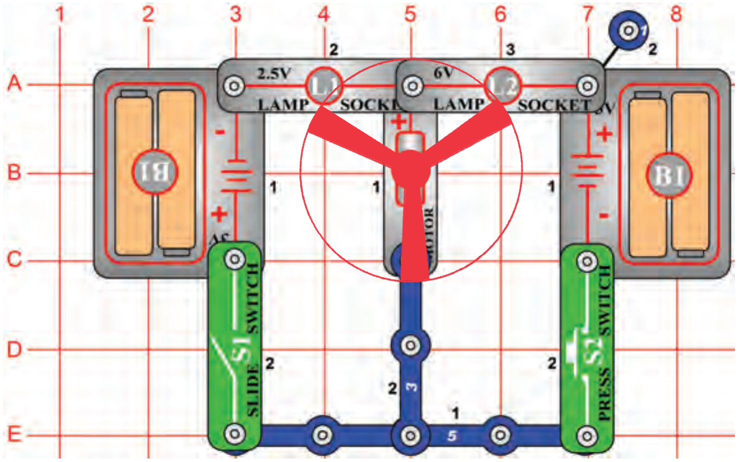
Turn the slide switch (S1) on and move the adjustable resistor (RV) control all the way up. The brightness of the LED (D1) is at maximum. Now, move the adjustable resistor control down until the LED goes out. Set the control up a little and the LED lights dimly.

Move your hand from side to side over the photoresistor (RP). As your hand blocks the light, the LED goes out.

The amount of light changes the resistance of the photoresistor and the current flow to the base of the NPN transistor (Q2). The transistor acts like a switch. Its base current is supplied through the photoresistor. As the base current changes, so does the current flow through the LED. With no base current, the LED goes out.

☐ Project #262 Motor Rotation

OBJECTIVE: To show how voltage polarity affects a DC motor.

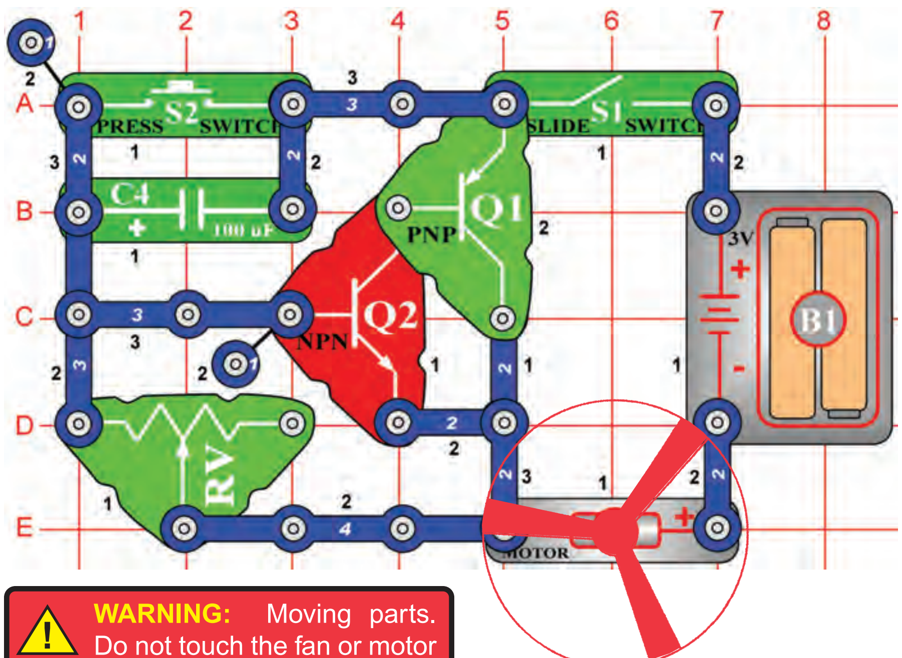


Place the fan onto the motor (M1). Press the press switch (S2). The fan rotates clockwise. When you connect the positive (+) side of the battery (B1) to the positive (+) side of the motor, it spins clockwise. Release the press switch and turn on the slide switch (S1). Now the fan spins the other way. The positive (+) side of the battery is connected to the negative (–) side of the motor. The polarity on the motor determines which way it rotates.

WARNING: Moving parts. Do not touch the fan or motor during operation. Do not lean over the motor.

☐ Project #263 Motor Delay Fan

OBJECTIVE: To build a circuit that controls how long the fan is on.



WARNING: Moving parts. Do not touch the fan or motor during operation. Do not lean over the motor.

Place the fan onto the motor (M1) and set the adjustable resistor (RV) control to the far right. Turn the slide switch (S1) on and then press the press switch (S2) once. The motor will spin and then stop. Now set the resistor control to the far left and press the press switch again. The time the fan spins is much less now.

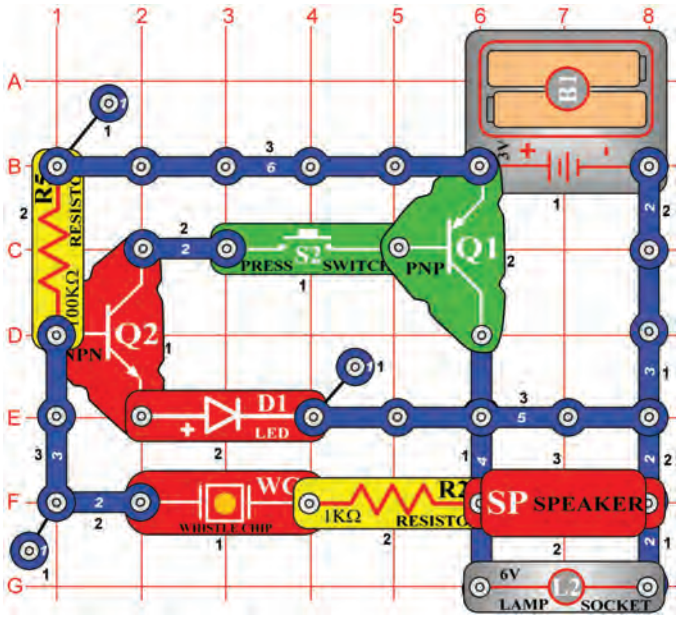
When the press switch is pressed, the current flows through the circuit and the fan spins. The 100μF capacitor (C4) charges up also. When the press switch is released, the capacitor discharges and supplies the current to keep the transistors (Q1 & Q2) on. The transistor acts like a switch connecting the fan to the battery. When the capacitor fully discharges, the transistors turn off and the motor stops. The adjustable resistor controls how fast the capacitor discharges. The more resistance, the longer the discharge time.

☐ Project #264 Motor Delay Fan (II)

OBJECTIVE: To change capacitance to affect time.

Use the circuit from project #263. Connect a single snap under the positive (+) side of the 470μF capacitor (C5) and then connect it over the top of the 100μF capacitor (C4). Turn the slide switch (S1) on and press the press switch (S2). Notice that the fan spins longer now. When capacitors are in parallel, the values are added, so now you have 570μF. The time it takes to discharge the capacitors is longer now, so the fan keeps spinning.

Project #265 High Pitch Bell



OBJECTIVE: To build a high pitch bell.

Build the circuit shown and press the press switch (S2). The circuit starts to oscillate. This generates the sound of a high pitch bell.

Project #266 Steamboat Whistle

OBJECTIVE: To build a steamboat whistle.

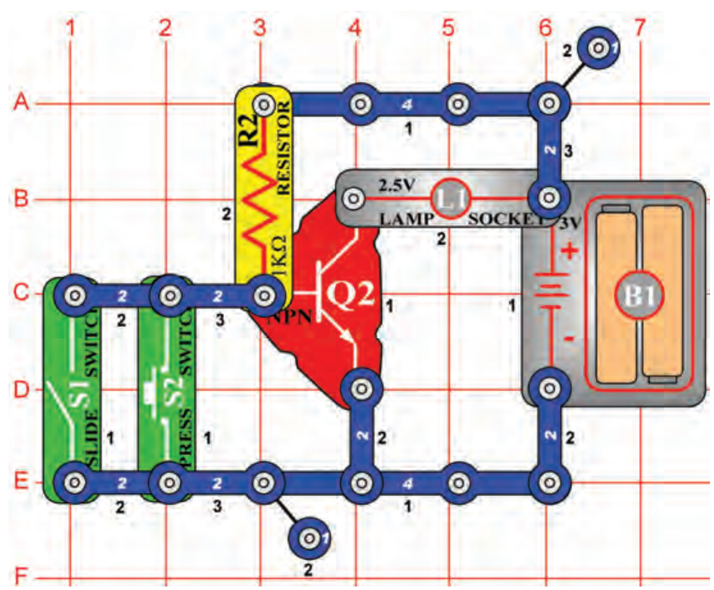
Using the circuit in project #265, connect the 0.02μF capacitor (C1) across the whistle chip (WC). Press the press switch (S2). The circuit now generates the sound of a steamboat.

Project #267 Steamship

OBJECTIVE: To generate the sound of a steamship.

Using the circuit in Project #265, connect the 0.1μF capacitor (C2) across the whistle chip. Press the press switch (S2). The circuit now generates the sound of a steamship.

Project #268 Light NOR Gate



OBJECTIVE: To build a NOR gate.

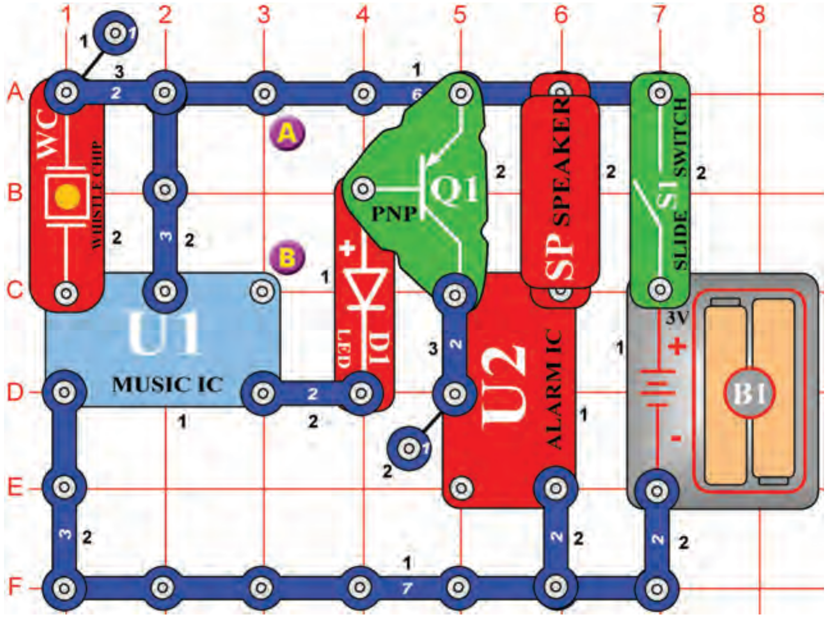
Build the circuit on the left. You will find that the lamp (L1) is on when neither the slide switch (S1) NOR the press switch (S2) are on. This is referred to as an NOR gate in electronics and is important in computer logic.

Example: If neither condition X NOR condition Y are true, then execute instruction Z.

Project #269

Noise-Activated Burglar Alarm

OBJECTIVE: To build a noise activated alarm.



Turn the slide switch (S1) on and wait for the sound to stop. Place the circuit into a room you want guarded. If a thief comes into the room and makes a loud noise, the speaker (SP) will sound again.

If you find that the sound does not turn off, then vibrations created by the speaker may be activating the whistle chip. Set the speaker on the table near the circuit and connect it to the same locations using the jumper wires to prevent this.

Project #270

Motor-Activated Burglar Alarm

OBJECTIVE: To build a motor-activated burglar alarm.

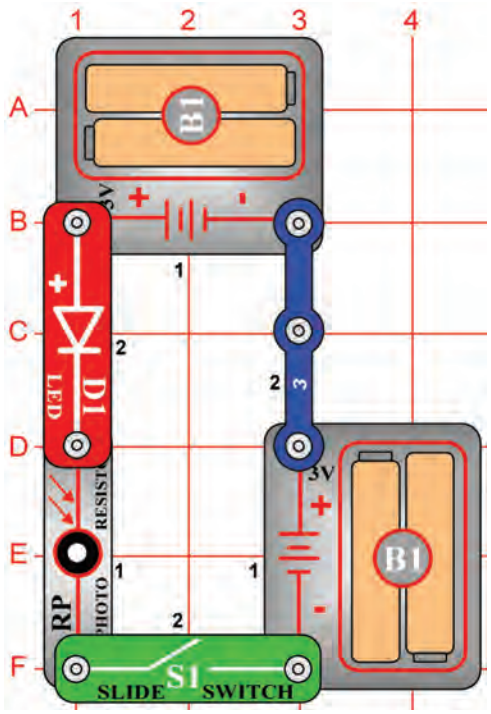
Use the circuit from project #269 shown above.
Replace the whistle chip (WC) with the motor (M1). Wind a piece of string around the axis of the motor so when you pull it the axes spins. Connect the other end of the string to a door or window. Turn the slide switch (S1) on and wait for the sound to stop. If a thief comes in through the door or window the string pulls and the axes spins. This will activate the sound.

Project #271

Light-Activated Burglar Alarm

OBJECTIVE: To build a light-activated burglar alarm.

Use the circuit from project #269 shown above.
Connect a photoresistor (RP) across points A & B and cover it or turn off the lights. Turn the slide switch (S1) on and wait for the sound to stop. At night, when the thief comes in and turns on the light, the speaker (SP) makes the sound of a machine gun.

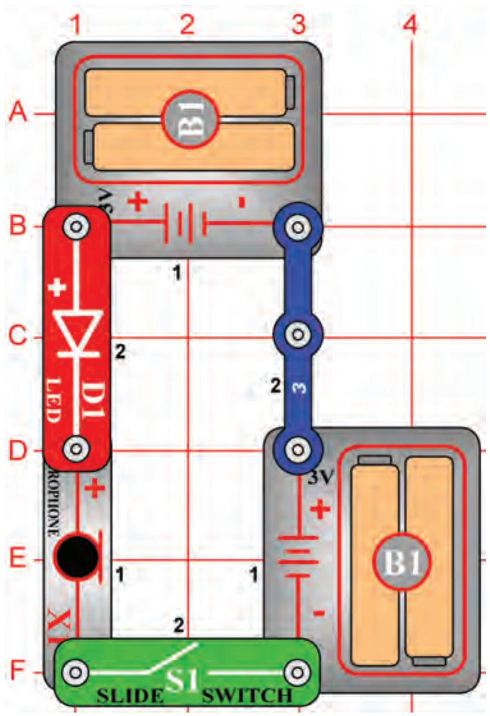


☐ Project #272
Photoresistor Control

OBJECTIVE: To use a photoresistor to control the brightness of an LED.

In this circuit, the brightness of the LED (D1) depends on how much light shines directly on the photoresistor (RP). If the photoresistor were held next to a flashlight or other bright light, then the LED would be very bright.

The resistance of the photoresistor decreases as more light shines on it. Photoresistors are used in applications such as streetlamps, which come on as it gets dark due to night or a severe storm.



☐ Project #273
Microphone Control

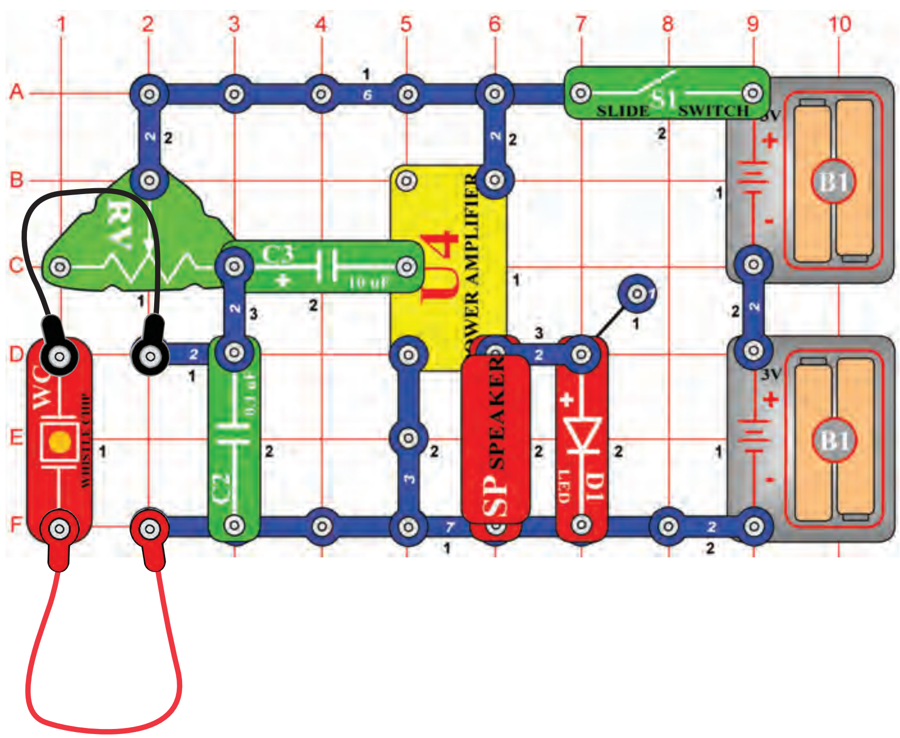
OBJECTIVE: To use a microphone to control the brightness of an LED.

In this circuit, blowing on the microphone (X1) changes the LED (D1) brightness.

The resistance of the microphone changes when you blow on it. You can replace the microphone with one of the resistors to see what resistor value it is closest to.

Project #274
Pressure Alarm

OBJECTIVE: To build a pressure alarm circuit.



Connect two jumper wires to the whistle chip (WC) as shown. Set the control of the adjustable resistor (RV) to the far left and turn on the switch. There is no sound from the speaker (SP) and the LED (D1) is off. Tap the center of the whistle chip. The speaker sounds and the LED lights. The whistle chip has a piezocrystal between the two metal plates. The sound causes the plates to vibrate and produce a small voltage. The voltage is amplified by the power amplifier IC (U4), which drive the speaker and LED.

Place a small object in the center of the whistle chip. When you remove the object the speaker and LED are activated. In alarm systems, a siren would sound to indicate the object has been removed.

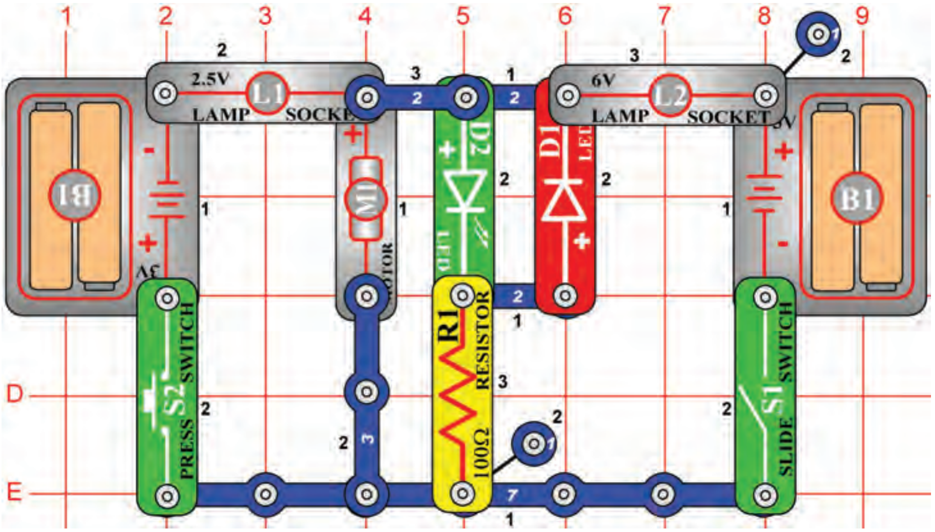
Project #275
Power Microphone

OBJECTIVE: To build a power microphone.

Use the circuit from project #274.

Replace the whistle chip with the microphone (X1), and hold it away from the speaker (SP). Set the control of the adjustable resistor (RV) to the far left. Turn on the slide switch (S1) and talk into the microphone. You now hear your voice on the speaker. The sound waves from your voice vibrate the microphone and produce a voltage. The voltage is amplified by the power amplifier IC (U4) and your voice is heard on the speaker.

Project #276 LED Fan Rotation Indicator



WARNING: Moving parts. Do not touch the fan or motor during operation. Do not lean over the motor.

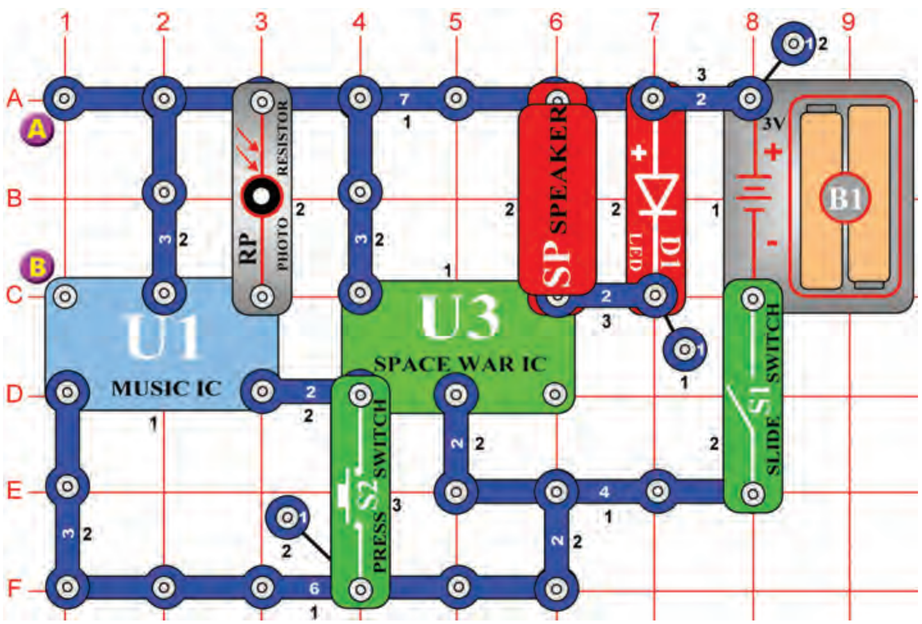
OBJECTIVE: To build an LED fan rotation indicator.

Do not place the fan onto the motor (M1). Turn the slide switch (S1) on. The motor rotates clockwise, and the green LED (D2) lights. When you connect the positive (+) side of the battery (B1) to the positive (+) side of the motor, it spins clockwise. Turn the slide switch off and press the press switch (S2). Now the fan spins the other way and the red LED (D1) lights. The positive (+) side of the battery is connected to the negative (–) side of the motor. The polarity on the motor determines which way it rotates.

Now place the fan on the motor, and turn on S1 or S2 (not both). Now one of the lamps (L1 or L2) lights as the motor spins, but the LED is dim.

The motor needs a lot of current to spin the fan, but only a little current to spin without it. In this circuit, a lamp lights when the motor current is high, and an LED lights when the motor current is low. The lamps also prevent a short circuit if both switches are on.

Project #277 Space War Sounds with LED



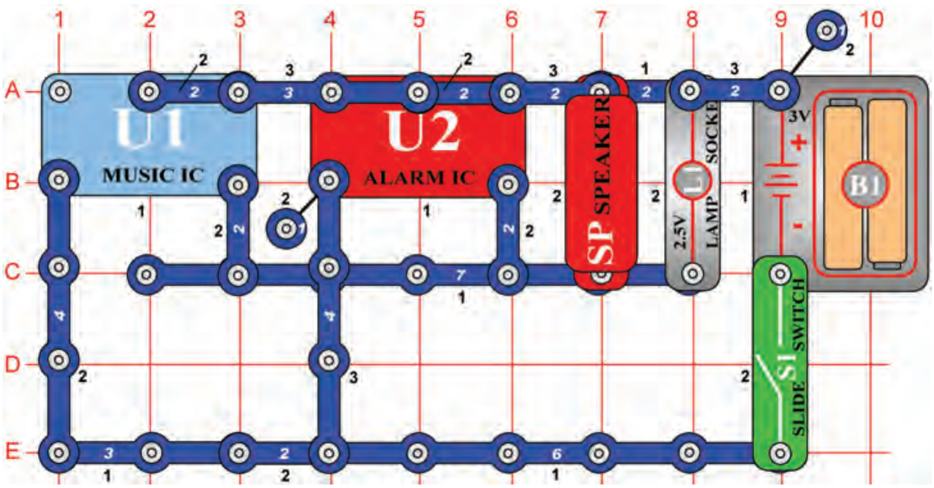
OBJECTIVE: To build a circuit that uses a programmed sound integrated circuit (IC).

Build the circuit shown on the left, which uses the space war integrated circuit (U3). Turn the slide switch (S1) on. A space war sound plays, and the LED (D1) flashes. If there is no light on the photoresistor (RP) then the sound will stop after a while.

You also make sounds by pressing the press switch (S2). See how many sounds are programmed into the space war sound IC.

Project #278 — Sound Mixer

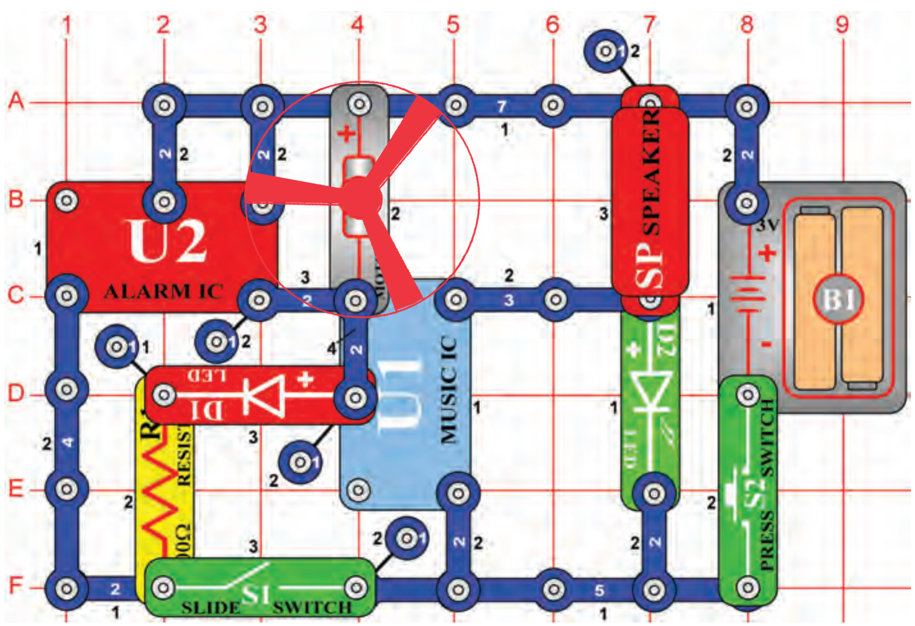
OBJECTIVE: To connect two sound IC's together.



In the circuit, the outputs from the alarm (U2) and music (U1) IC's are connected together. The sounds from both IC's are played at the same time.

Project #279 — Sound Mixer Fan Driver

OBJECTIVE: To connect two sound IC's together to drive two LED's and a motor.

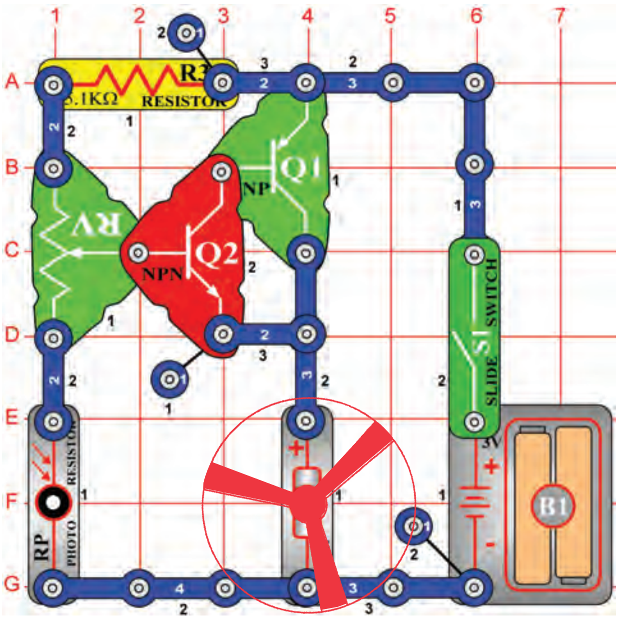


Build the circuit shown on the left. Place the fan onto the motor (M1).

In the circuit, the alarm IC (U2) and the music IC (U1) are connected together. The sounds from both IC's can be played at the same time. Press the press switch (S2). The music IC plays and the green LED (D2) lights. Now turn on the slide switch (S1) and press the press switch again. You should hear the sounds from both IC's playing. As the alarm IC plays, it also drives the fan and the red LED (D1).

WARNING: Moving parts. Do not touch the fan or motor during operation. Do not lean over the motor.

Project #280



Electric Fan Stopped by Light

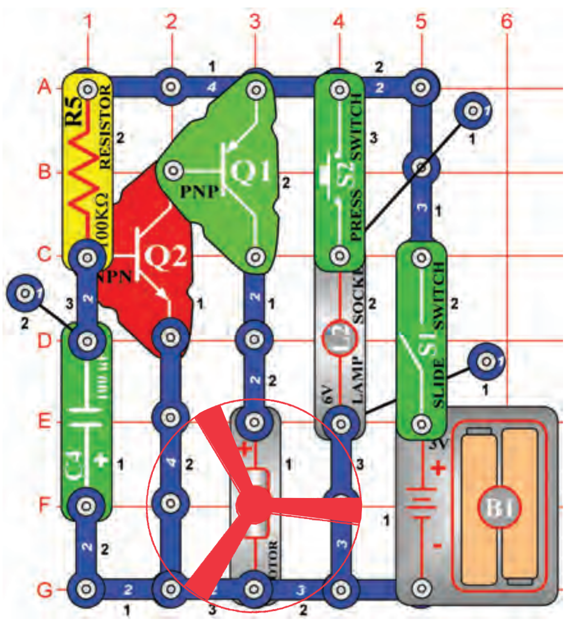
OBJECTIVE: To show how light can control a motor.

Turn on the slide switch (S1) and set the adjustable resistor (RV) control so the motor (M1) just starts spinning. Slowly cover the photoresistor (RP) and the motor spins faster. By placing more light over the photoresistor, the motor slows.

The fan will not move on most settings of the resistor, because the resistance is too high to overcome friction in the motor. If the fan does not move at any resistor setting, then replace your batteries.

WARNING: Moving parts. Do not touch the fan or motor during operation. Do not lean over the motor.

Project #281



Motor & Lamp

OBJECTIVE: To control large currents with a small one.

Place the fan on the motor (M1). Turn on the slide switch (S1) and the motor spins. The transistors are like two switches connected in series. A small current turns on the NPN transistor (Q2), which turns on the PNP transistor (Q1). The large current used to spin the motor now flows through the PNP. The combination allows a small current to control a much larger one.

Press the press switch (S2) and the lamp (L2) lights and slows the motor. When the lamp lights, the voltage across the motor decreases and slows it down.

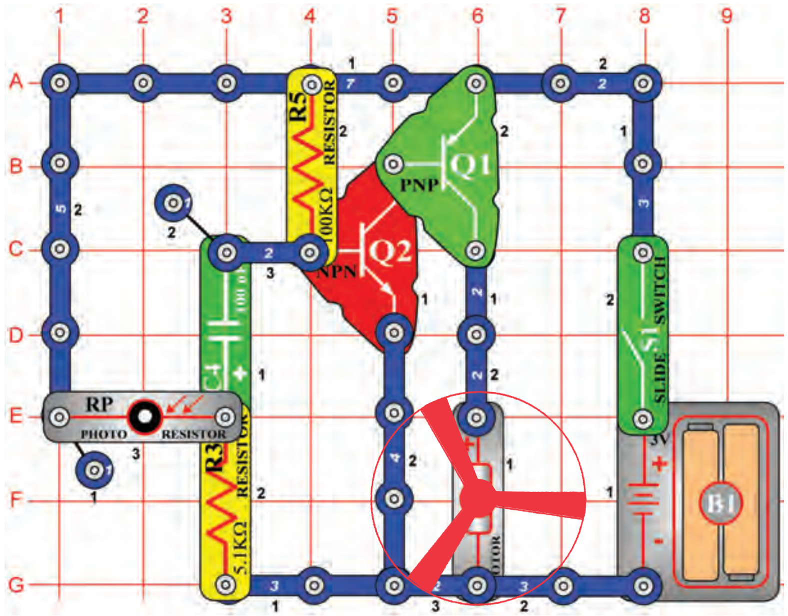
The fan will not move on most settings of the resistor, because the resistance is too high to overcome friction in the motor. If the fan does not move at any resistor setting, then replace your batteries.

WARNING: Moving parts. Do not touch the fan or motor during operation. Do not lean over the motor.

Project #282

Start-Stop Delay

OBJECTIVE: To start and stop a motor with light.



Place the fan on the motor (M1). Turn on the slide switch (S1), the motor starts spinning. As you move your hand over the photoresistor, (RP) the motor slows. Now place a finger on top of the photoresistor to block the light. The motor slows down. In a few seconds the motor speeds up again.

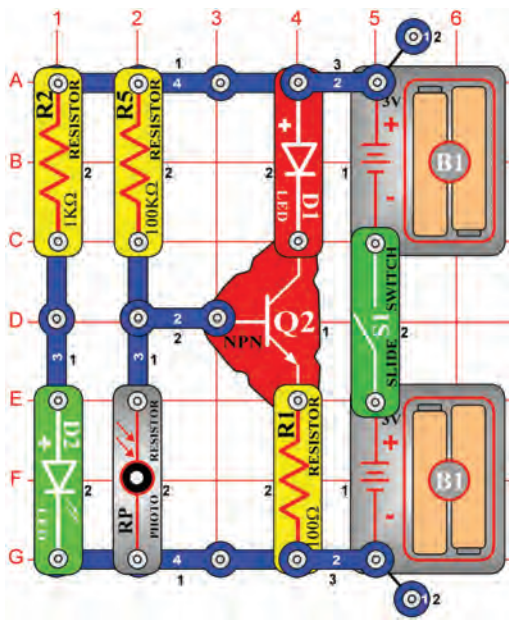
The fan will not move on most settings of the resistor, because the resistance is too high to overcome friction in the motor. If the fan does not move at any resistor setting, then replace your batteries.

WARNING: Moving parts. Do not touch the fan or motor during operation. Do not lean over the motor.

Project #283

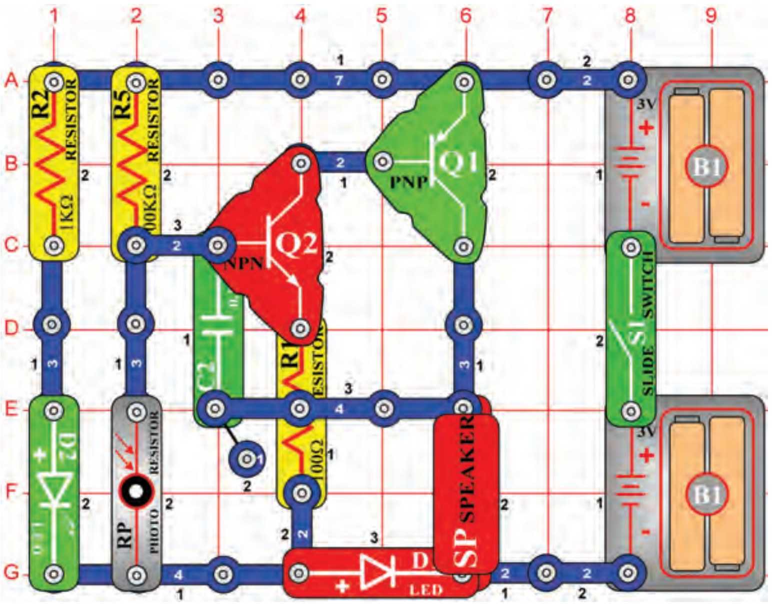
Mail Notifying System

OBJECTIVE: To build a circuit to indicate if you have mail.



Turn on the slide switch (S1). If there is light on the photoresistor (RP) the red LED (D1) will not light. Place your finger over the photoresistor and now the red LED lights. A simple mail notifying system can be made using this circuit. Install the photoresistor and the green LED (D2) inside the mailbox facing each other. Place the red LED outside the mailbox. When there is mail, the light is blocked from the photoresistor and the red LED turns on.

☐ Project #284 Mail Notifying Electronic Bell



OBJECTIVE: To build a circuit to indicate if you have mail by sounding a tone.

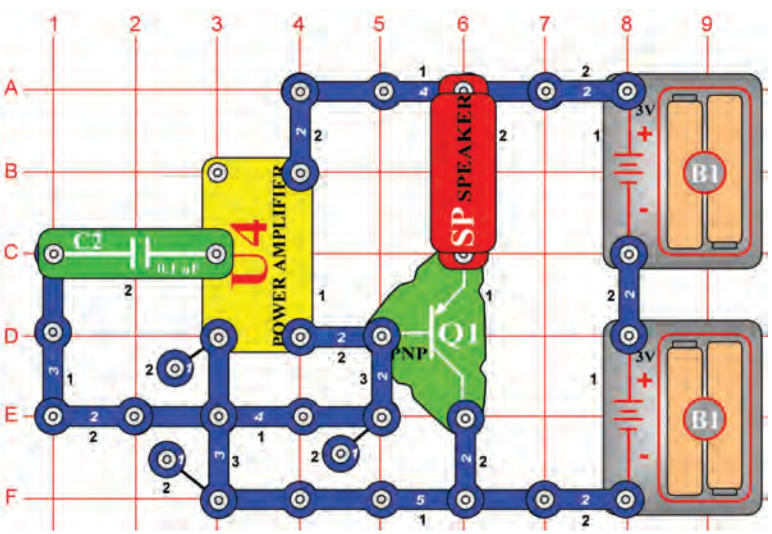
Turn on the slide switch (S1). If there is enough light on the photoresistor (RP), the speaker (SP) will not make any sound. Place your finger over the photoresistor and now the speaker sounds. The sound will stay on until you turn off the slide switch. A simple mail notifying system can be made using this circuit. Install the photoresistor and the green LED inside the mailbox facing each other. When there is mail, the light is blocked from the photoresistor and the speaker turns on.

☐ Project #285 Mail Notifying Electronic Lamp

OBJECTIVE: To build a circuit to indicate if you have mail by activating the lamp.

Replace the speaker (SP) with the lamp (L2). When there is mail, the light is blocked from the photoresistor (RP) and the lamp lights.

☐ Project #286 Twice-Amplified Oscillator



OBJECTIVE: To build an oscillating circuit.

The tone you hear is the frequency of the oscillator. Install different values of capacitors in place of the 0.1μF capacitor (C2) to change the frequency.

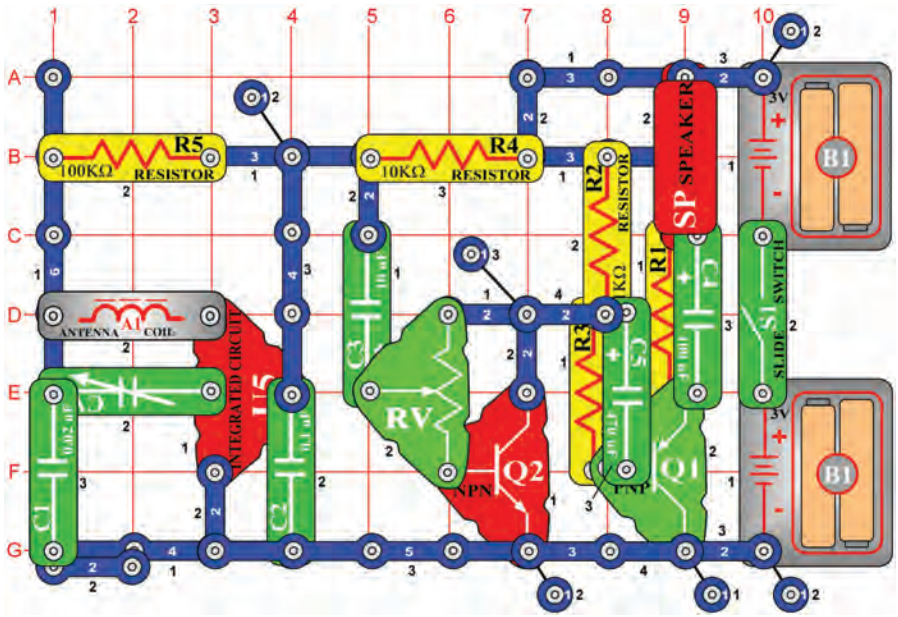
☐ Project #287 Quick Flicking LED

OBJECTIVE: To build a flicking LED circuit.

Use the circuit from project #286. Replace the speaker (SP) with a red LED (D1, the "+" sign on top). Now you see the frequency of the oscillator. Install different values of capacitors to change the frequency.

Project #288 AM Radio with Transistors

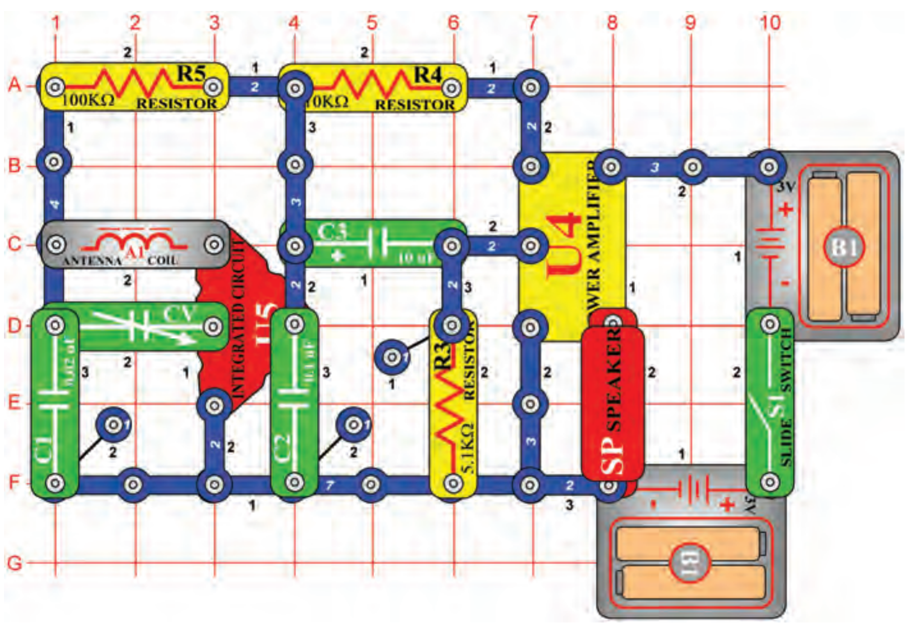
OBJECTIVE: To build a complete, working AM radio with transistor output.



When you turn on the slide switch (S1), the integrated circuit (U5) should amplify and detect the AM radio waves. Tune the variable capacitor (CV) to the desirable station. Set the adjustable resistor (RV) for the best sound. The two transistors (Q1 & Q2) drive the speaker (SP) to complete the radio. The radio will not be very loud.

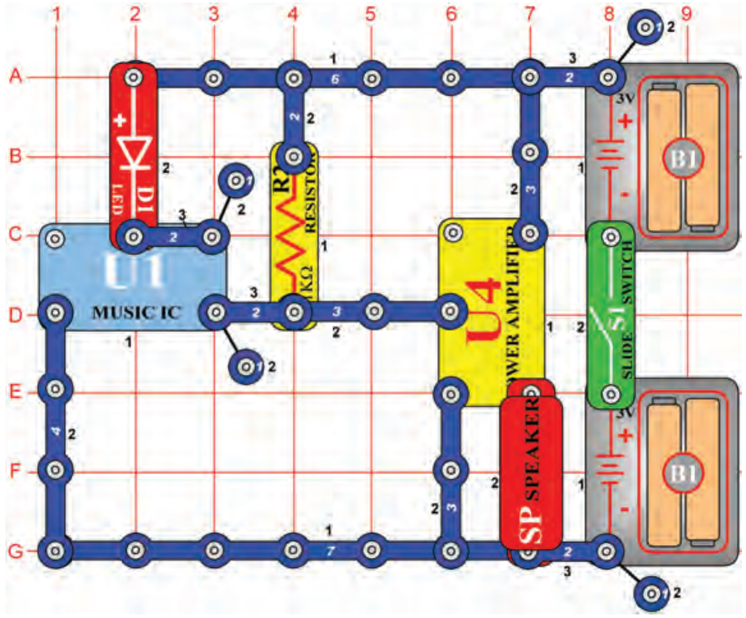
Project #289 AM Radio (II)

OBJECTIVE: To build a complete, working AM radio.



When you close the slide switch (S1), the integrated circuit (U5) should detect and amplify the AM radio waves. The signal is then amplified using the power amplifier (U4), which drives the speaker (SP). Tune the variable capacitor (CV) to the desirable station.

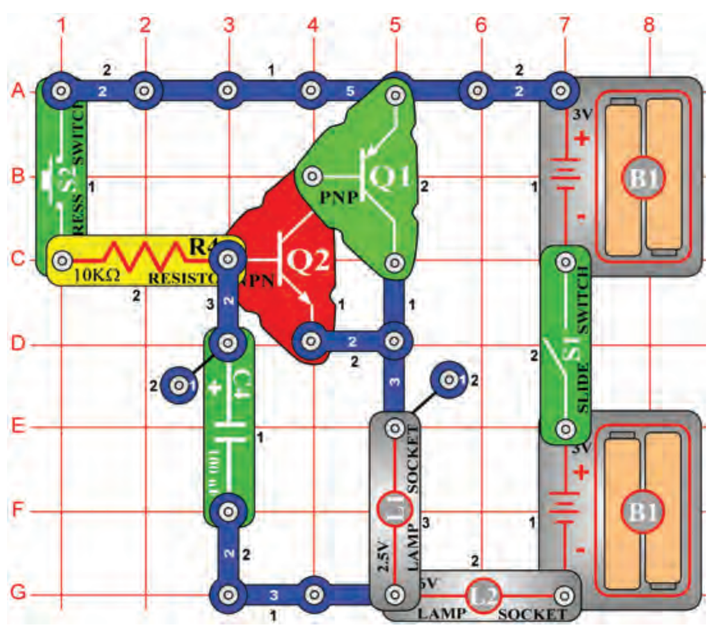
☐ Project #290 Music Amplifier



OBJECTIVE: To amplify sounds from the music integrated circuit.

Build the circuit and turn on the slide switch (S1). You will hear loud music, since the sound from the music IC (U1) is amplified by the power amplifier IC (U4). All radios and stereos use a power amplifier.

☐ Project #291 Delayed Action Lamp



OBJECTIVE: To build a lamp that stays on for a while.

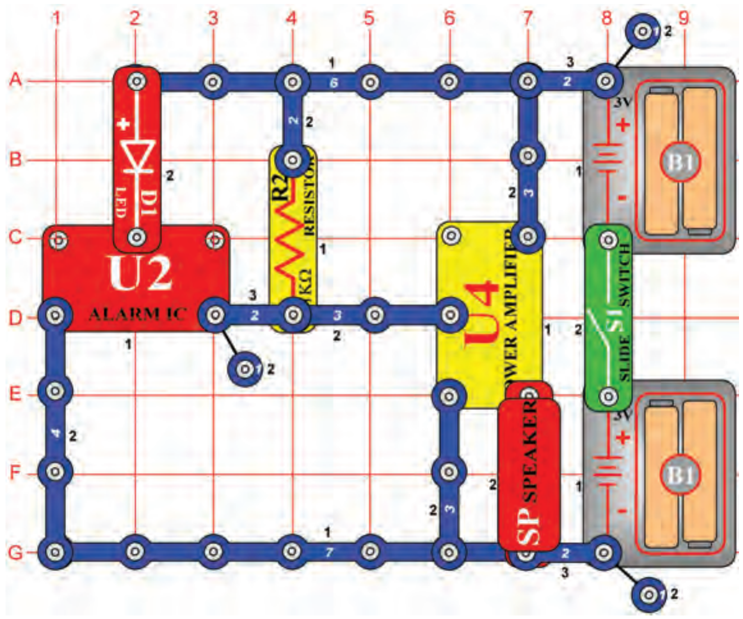
Turn on the slide switch (S1) and press the press switch (S2). The lamps (L1 & L2) turn on slowly, but stay on for a while after you release the press switch.

☐ Project #292 Delayed Action Fan

OBJECTIVE: To build a fan that stays on for a while.

Replace the lamp (L1) with the motor (M1), positive (+) side up. Be sure to put on the fan. Turn on the slide switch (S1) and press the press switch (S2). The fan turns on slowly but stays on for a while after you release the press switch.

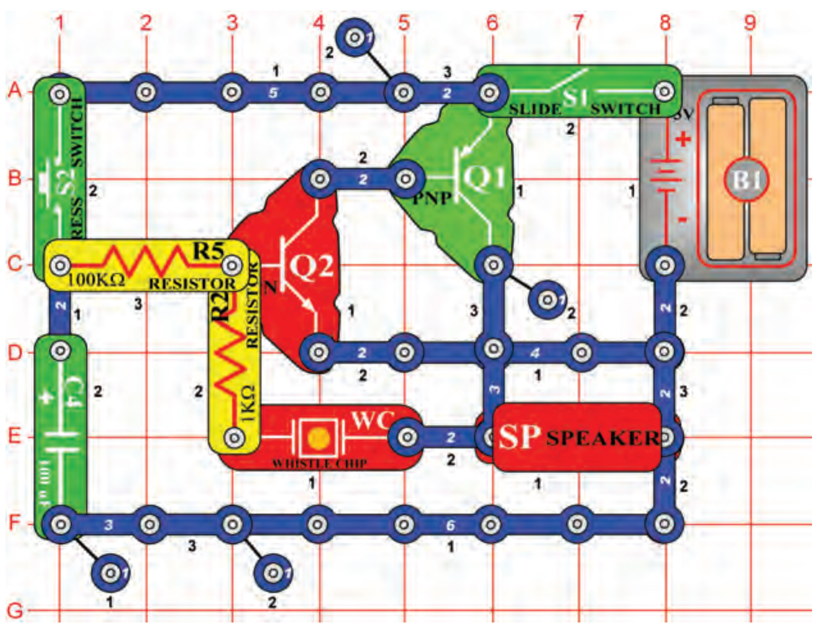
☐ Project #293 Police Siren Amplifier



***OBJECTIVE:** To amplify sounds from the music integrated circuit.*

Build the circuit and turn on the slide switch (S1). You will hear a very loud siren, since the sound from the alarm IC (U2) is amplified by the power amplifier IC (U4). Sirens on police cars use a similar circuit, with an IC to create the sound and a power amplifier to make it very loud.

☐ Project #294 Lasting Doorbell



***OBJECTIVE:** To build a doorbell that stays on for a while.*

Build the circuit at left, note that there is a 4-snap wire on layer 1 that is not connected to a 3-snap wire that runs over it on layer 3. Turn on the slide switch (S1), then press and release the press switch (S2). There is a doorbell sound that slowly fades away.

When the press switch is pressed, the transistors are supplied with current for oscillation. At the same time, the 100μF capacitor (C4) is being charged. When the press switch is released, the capacitor discharges and keeps the oscillation going for a while.

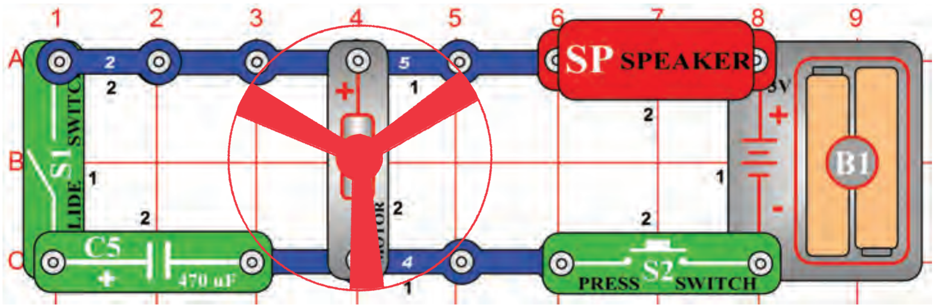
☐ Project #295 Lasting Clicking

***OBJECTIVE:** To build a clicker that stays on for a while.*

Place the 10μF capacitor (C3) on top of the whistle chip (WC). Press and release the press switch (S2). It makes a clicking sound that repeats for a while.

Project #296 Quieting a Motor

OBJECTIVE: To show how capacitors can filter out electrical disturbances.



Place the fan on the motor (M1) and turn off the slide switch (S1). Press the press switch (S2) and listen to the motor.

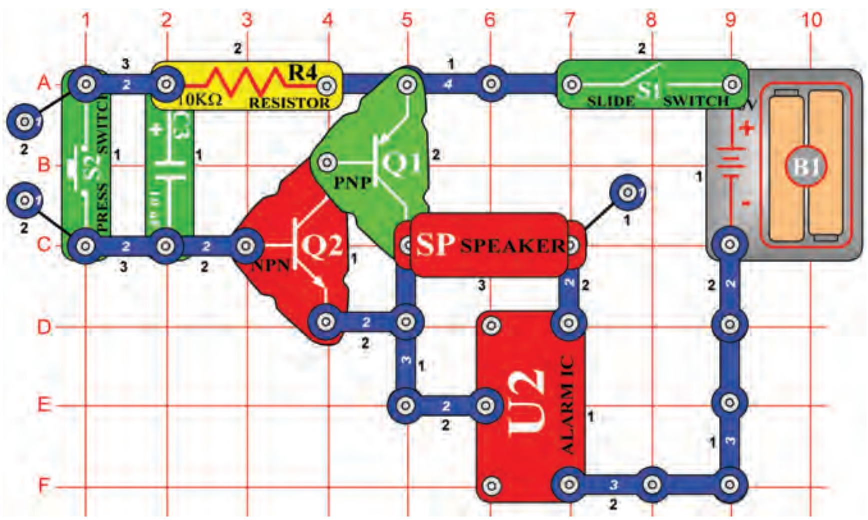
As the motor shaft spins around it connects/ disconnects several sets of electrical contacts. As these contacts are switched, an electrical disturbance is created, which the speaker converts into sound.

Turn on the slide switch and push the press switch again. The fan spins just as fast, but the sound is not as loud. Capacitors, like the 470μF capacitor (C5), are often used to filter out undesired electrical disturbances. If you replace C5 with one of the other capacitors in your set then the sound will not be changed as much.

WARNING: Moving parts. Do not touch the fan or motor during operation. Do not lean over the motor.

Project #297 Transistor Fading Siren

OBJECTIVE: To build a siren that slowly fades away.



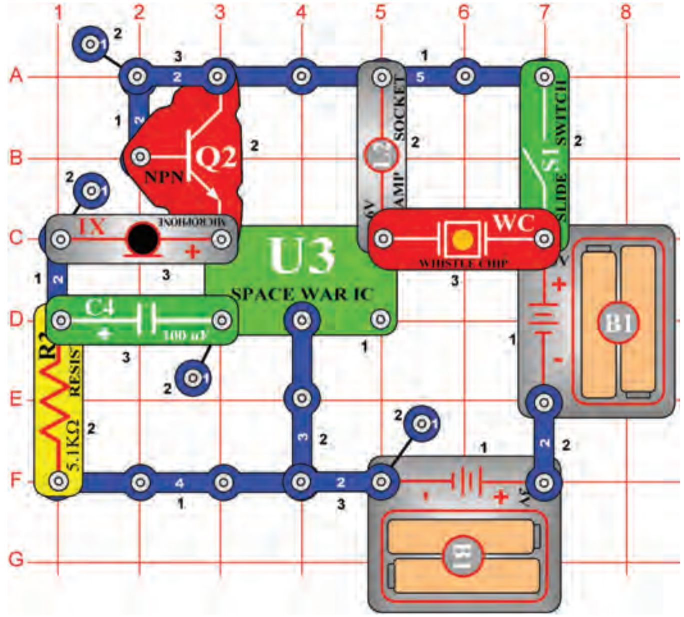
Turn on the slide switch (S1), then press and release the press switch (S2). You hear a siren that slowly fades away and eventually goes off. You can modify this circuit to make machine gun or ambulance sound instead like in the other projects. You can also replace the 10μF capacitor (C3) with the 100μF (C4) or 0.1μF (C2) to greatly slow down or speed up the fading.

Project #298 Fading Doorbell

OBJECTIVE: To build a doorbell that slowly fades away.

Replace the alarm IC (U2) with the music IC (U1). The circuit has a doorbell sound that plays and stops.

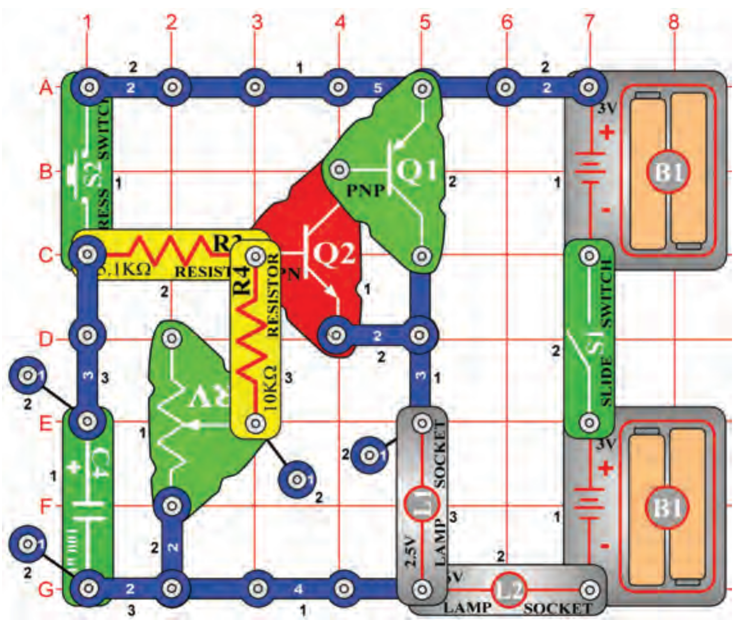
☐ Project #299 Blowing Space War Sounds



OBJECTIVE: To change space war sounds by blowing.

Turn on the slide switch (S1) and you will hear explosion sounds and the lamp is on or flashing. Blow into the microphone (X1) and you can change the sound pattern.

☐ Project #300 Adjustable Time Delay Lamp



OBJECTIVE: To build a lamp that stays on for a while.

Turn on the slide switch (S1) and press the press switch (S2). The lamps stay on for a while after you release the press switch. You can change the delay time with the adjustable resistor (RV).

☐ Project #301 Adjustable Time Delay Fan

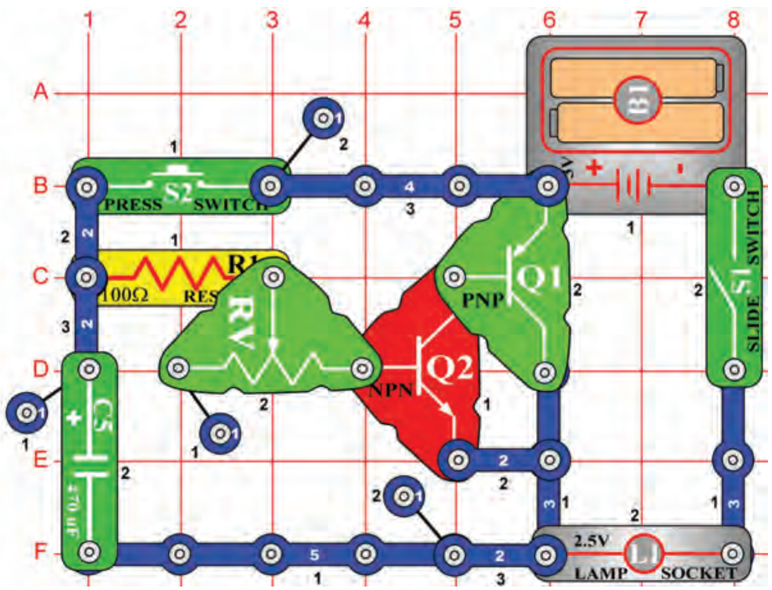
OBJECTIVE: To build a fan that stays on for a while.

Replace the lamp (L1) with the motor (M1), be sure to put on the fan. Turn on the slide switch (S1) and press the press switch (S2). The fan stays on for a while after you release the press switch. You can change the delay time with the adjustable resistor (RV).

WARNING: Moving parts. Do not touch the fan or motor during operation. Do not lean over the motor.

☐ Project #302

Adjustable Time Delay Lamp (II)



OBJECTIVE: To build a lamp that stays on for a while.

Be sure to use the 2.5V lamp (L1) for this circuit. Turn on the switch and press the press switch (S2). The lamp stays on for a few seconds after you release the press switch. You can change the delay time with the adjustable resistor (RV).

☐ Project #303

Adjustable Time Delay Fan (II)

OBJECTIVE: To build a fan that stays on for a while.

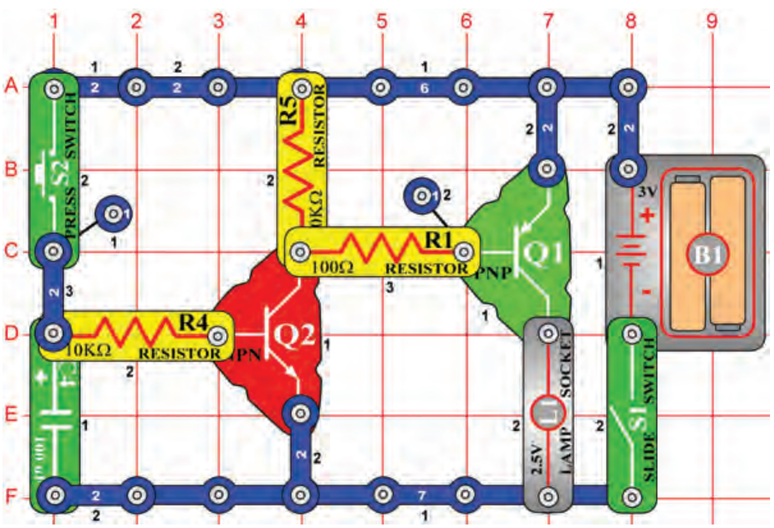
Replace the lamp (L1) with the motor (M1), be sure to put on the fan. Turn on the switch and press the press switch (S2). The fan stays on for a while after you release the press switch. You can change the delay time with the adjustable resistor (RV).

WARNING: Moving parts. Do not touch the fan or motor during operation. Do not lean over the motor.

☐ Project #304

Watch Light

OBJECTIVE: To build a lamp that stays on for a while.



Turn on the switch and press the press switch (S2). The lamp stays on for a few seconds after you release the press switch.

A miniature version of a circuit like this might be in your wristwatch - when you press a light button on the watch to read the time in the dark, a light comes on but automatically turns off after a few seconds to avoid draining the battery.

☐ Project #305

Delayed Bedside Fan

OBJECTIVE: To build a fan that stays on for a while.

Replace the lamp (L1) with the motor (M1, positive (+) side up), be sure to put on the fan. Turn on the switch and press the press switch (S2). The fan stays on for a while after you release the press switch. This could have a longer delay and be near your bed, to turn off after you fall asleep.

WARNING: Moving parts. Do not touch the fan or motor during operation. Do not lean over the motor.

OTHER SNAP CIRCUITS® PROJECTS!

For a listing of local toy retailers who carry Snap Circuits®, please visit **www.elenco.com** or call us toll-free at (800) 533-2441. For Snap Circuits® upgrade kits, accessories, additional parts, and more information about your parts, please visit **www.snapcircuits.net**.

Upgrade Kit
Model UC-50

Build 200 Additional Projects

Including:

- Electronic Cat
- Music Meter
- Adjustable Light Control
- Digitally Tuned FM Radio
- Digital Voice Recorder
- Light Controlled Music
- AC Generator
- Flashing Numbers

Contains 12 New Parts

Including:

- FM Radio Module
- Analog Meter
- Recording IC Module
- Diode
- 7-Segment LED Display
- Relay
- SCR
- Transformer

Upgrade Kit
Model UC-70

Build Over 450 Additional Projects

Including:

- Strobe Light
- Electromagnetism
- Electronic Kazoo
- Transistor AM Radio
- Rechargeable Battery
- Solar Batteries
- Mega Pulser and Flasher
- Paperclip Compass

Contains 22 New Parts

Including:

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- Electromagnet
- Vibration Switch
- Two-spring Socket
- Bag of Paperclips

- **Includes the CI-73 Computer Interface**

Put your circuits in motion!

Deluxe Snap Rover®
Model SCROV-50

Introducing the next generation of the RC Snap Rover®! This version includes a disc launcher, digital voice recorder, and music sounds. Over 50 parts allow you to complete over 40 additional projects.

- **Includes 30 parts**
- **Build over 20 projects**
- **Full-color assembly manual**
- **Sound effects**

If you want to enhance your Snap Circuits® experience and get even smarter, then try

Snap Circuits® Student Guide
Part # 753307

For use with SC-300

Educational Series - teaches Basic Electricity and Electronics in the everyday world using our Learn By Doing® concept! 80 full-color pages, and written with the help of educators.

Snap Circuits® Green
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Learn about energy sources and how to "think green". Build over 125 projects and have loads of fun learning about environmentally-friendly energy and how the electricity in your home works. Includes full-color manual with over 100 pages and separate educational manual. This educational manual will explain all the forms of environmentally-friendly energy including: geothermal, hydrogen fuel cells, wind, solar, tidal, hydro, and others. Contains over 40 parts.

Snap Circuits® LIGHT
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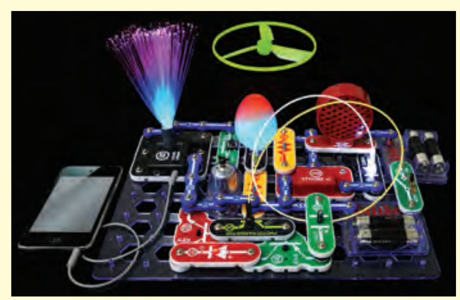
Features:

- Infrared detector
- Strobe light
- Color changing LED
- Glow-in-the-dark fan
- Strobe integrated circuit (IC)
- Fiber optic communication
- Color organ controlled by iPod® or other MP3 player, voice, and fingers.

Build over 175 projects!

Contains over 60 parts



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ELECTRONIC SNAP CIRCUITS®

Projects 306-511

AGE 8 - 108

Project 317

SNAP CIRCUITS®

Instruction Manual

ELENCO®

REV-D Revised 2012 753104

Table of Contents

WARNING: SHOCK HAZARD - Never connect Snap Circuits® to the electrical outlets in your home in any way!

WARNING: CHOKING HAZARD - Small parts. Not for children under 3 years.

WARNING FOR ALL PROJECTS WITH A ⚠ SYMBOL
Moving parts. Do not touch the motor or fan during operation. Do not lean over the motor. Do not launch the fan at people, animals, or objects. Eye protection is recommended.

Basic Troubleshooting

1. **Most circuit problems are due to incorrect assembly. Always double-check that your circuit exactly matches the drawing for it.**
2. **Be sure that parts with positive/negative markings are positioned as per the drawing.**
3. **Be sure that all connections are securely snapped.**
4. **Try replacing the batteries.**
5. **If the motor spins but does not balance the fan, check the black plastic piece with three prongs on the motor shaft. Be sure that it is at the top of the shaft.**

Elenco® is not responsible for parts damaged due to incorrect wiring.

Note: If you suspect you have damaged parts, you can follow the Advanced Troubleshooting procedure on page 4 to determine which ones need replacing.

Batteries:

- **Use only 1.5V AA type, alkaline batteries (not included).**
- **Insert batteries with correct polarity.**
- **Non-rechargeable batteries should not be recharged. Rechargeable batteries should only be charged under adult supervision, and should not be recharged while in the product.**
- **Do not mix alkaline, standard (carbon-zinc), or rechargeable (nickel-cadmium) batteries.**
- **Do not mix old and new batteries.**
- **Remove batteries when they are used up.**
- **Do not short circuit the battery terminals.**
- **Never throw batteries in a fire or attempt to open its outer casing.**
- **Batteries are harmful if swallowed, so keep away from small children.**
- **Do not connect batteries or battery holders in parallel.**

WARNING: Always check your wiring before turning on a circuit. Never leave a circuit unattended while the batteries are installed. Never connect additional batteries or any other power sources to your circuits. Discard any cracked or broken parts.

Adult Supervision: Because children's abilities vary so much, even with age groups, adults should exercise discretion as to which experiments are suitable and safe (the instructions should enable supervising adults to establish the experiment's suitability for the child). Make sure your child reads and follows all of the relevant instructions and safety procedures, and keeps them at hand for reference.

This product is intended for use by adults and children who have attained sufficient maturity to read and follow directions and warnings.

Never modify your parts, as doing so may disable important safety features in them, and could put your child at risk of injury.

Review of How To Use It (See page 3 of the Projects 1-101 manual for more details.)

The Snap Circuits® kit uses building blocks with snaps to build the different electrical and electronic circuits in the projects. These blocks are in different colors and have numbers on them so that you can easily identify them. The circuit you will build is shown in color and with numbers, identifying the blocks that you will use and snap together to form a circuit.

Next to each part in every circuit drawing is a small number in black. This tells you which level the component is placed at. Place all parts on level 1 first, then all of the parts on level 2, then all of the parts on level 3, etc.

A large clear plastic base grid is included with this kit to help keep the circuit block together. The base has rows labeled A-G and columns labeled 1-10.

Install two (2) "AA" batteries (not included) in the battery holder (B1). The 2.5V and 6V bulbs come packaged separate from their sockets. Install the 2.5V bulb in the L1 lamp socket, and the 6V bulb in the L2 lamp socket.

Place the fan on the motor (M1) whenever that part is used, unless the project you are building says not to use it.

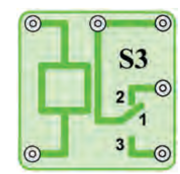
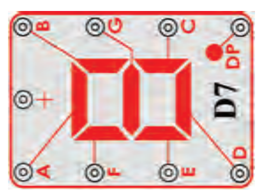
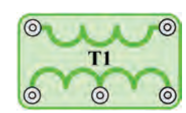
Some circuits use the red and black jumper wires to make unusual connections. Just clip them to the metal snaps or as indicated.

Note: While building the projects, be careful not to accidentally make a direct connection across the battery holder (a "short circuit"), as this may damage and/or quickly drain the batteries.

Parts List (Colors and styles may vary) Symbols and Numbers

Note: There are additional part lists in your other project manuals. Part designs are subject to change without notice.

Important: If any parts are missing or damaged, **DO NOT RETURN TO RETAILER**. Call toll-free (800) 533-2441 or e-mail us at: help@elenco.com. Customer Service • 150 Carpenter Ave. • Wheeling, IL 60090 U.S.A.

Qty.	ID	Name	Symbol	Part #	Qty.	ID	Name	Symbol	Part #
❒ 3	(2)	2-Snap Wire		6SC02	❒ 1	(M2)	Analog Meter		6SCM2
❒ 1	(5)	5-Snap Wire		6SC05	❒ 1	(Q3)	SCR		6SCQ3
❒ 1	(D3)	Diode 1N4001		6SCD3	❒ 1	(S3)	Relay		6SCS3
❒ 1	(D7)	7-Segment LED Display		6SCD7	❒ 1	(T1)	Transformer		6SCT1
❒ 1	(FM)	FM Module		6SCFM	❒ 1	(U6)	Recording Integrated Circuit		6SCU6

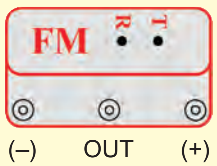
You may order additional / replacement parts at our website: www.snapcircuits.net

MORE About Your New Snap Circuits® Parts (Note: There is additional information in your other project manuals).

Our Student Guides give much more information about your parts, along with a complete lesson in basic electronics. See www.snapcircuits.net/learn.htm or page 62 for more information.

(Part designs are subject to change without notice).

The **FM module (FM)** contains an integrated FM radio circuit. Refer to the figure below for the pinout description.

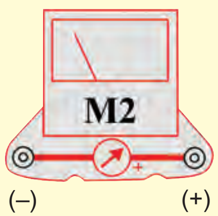


FM Module:

(+) - power from batteries
(–) - power return to batteries
T - tune up
R - reset
OUT - output connection

See project #307 for example of proper connections.

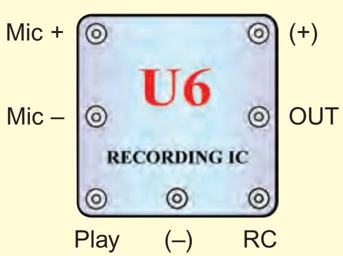
The **meter (M2)** is a very important indicating and measuring device. You'll use it to measure the amount of current or voltage depending on the circuit configuration. Notice the meter has a "+" sign, indicating the positive terminal (+ power from the batteries). The other snap is the negative terminal (– power return to batteries). The meter has a switch to change between scales, indicated as LOW and HIGH (or 10mA and 1A).



Meter:

(+) - power from batteries
(–) - power return to batteries

The **recording IC module (U6)** contains an integrated recording circuit. You can record a message up to five seconds long. There are also three pre-recorded songs. Refer to the figure below for the pinout descriptions:

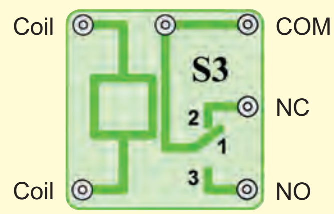


Recording IC Module:

(+) - power from batteries
(–) - power return to batteries
RC - record
Play - play
OUT - output connection
Mic + - microphone input
Mic – - microphone input

See project #308 for example of proper connections.

The **relay (S3)** is an electronic switch with contacts that can be closed or opened. It contains a coil that generates a magnetic field when current flows through it. The magnetic field attracts an iron armature, which switches the contacts (see figure).

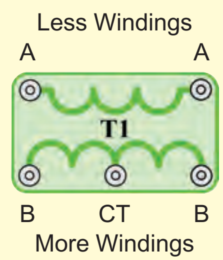


Relay:

Coil - connection to coil
Coil - connection to coil
NC - normally closed contact
NO - normally open contact
COM - Common

See project #341 for example of proper connections.

The **transformer (T1)** consists of two coil windings on one core. One coil is called the Primary (input) and the other the Secondary (output). The purpose of the transformer is to increase the amount of AC voltage applied to the primary. This transformer is a step-up transformer.



Transformer:

A - less windings side
A - less windings side
B - more windings side
B - more windings side
CT - center tap

See project #347 for example of proper connections.

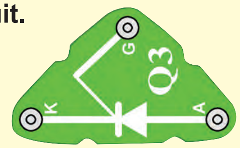
Diode (D3) - Think of a diode as a one-way valve that permits current flow in the direction of the arrow. The anode (arrow) is the positive side, and the cathode (bar) is the negative. The diode conducts or turns on when the voltage at the anode is 0.7V or greater.

Diode:

Anode - (+)
Cathode - (–)

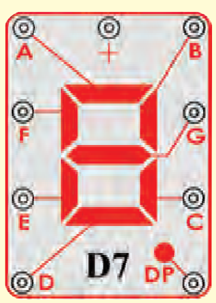
MORE About Your Snap Circuits® Parts (continued)

SCR (Q3) - An SCR is a three-pin (anode, cathode and gate) silicon-controlled rectifier diode. Like a standard diode, it permits current flow in only one direction. It will only conduct in the forward direction when triggered by a short pulse (or steady voltage applied) between the gate and cathode terminals. **A high current may damage this part, so the current must be limited by other components in the circuit.**



SCR:
A - Anode
K - Cathode
G - Gate

The **7-segment display (D7)** is found in many devices today. It contains 7 LED's that have been combined into one case to make a convenient device for displaying numbers and some letters. The display is a common anode version. That means that the positive leg of each LED is connected to a common point which is the snap marked "+". Each LED has a negative leg that is connected to one snap. To make it work you need to connect the "+" snap to positive three volts. Then to make each segment light up, connect the snaps of each LED to ground. In the projects, a resistor is always connected to the "+" snap to limit the current. **A high current may damage this part, so the current must be limited by other components in the circuit.**



7-segment Display:
(+) - power from batteries
A - Segment A
B - Segment B
C - Segment C
D - Segment D
E - Segment E
F - Segment F
G - Segment G
DP - Decimal Point

See project #337 for example of proper connections.

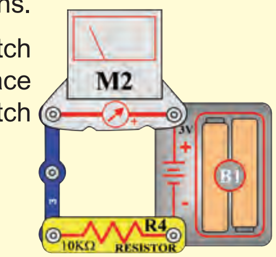
MORE Advanced Troubleshooting (Adult supervision recommended)

Elenco® is not responsible for parts damaged due to incorrect wiring.

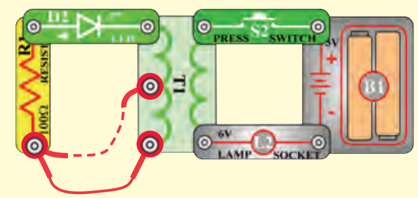
If you suspect you have damaged parts, you can follow this procedure to systematically determine which ones need replacing:

1 - 20. Refer to project manuals 1 & 2 (projects #1-101, #102-305) for testing steps 1-20, then continue below.

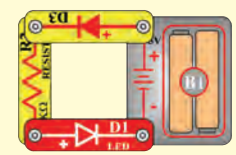
21. **FM Module (FM):** Build project #307, you should hear FM radio stations.
22. **Meter (M2):** Build the mini-circuit shown here and set the meter switch to LOW (or 10mA), the meter (M2) should deflect full scale. Then, replace the 10kΩ resistor (R4) with the 2.5V lamp (L1), and set the meter switch to HIGH (or 1A). The meter should deflect to 1 or higher.



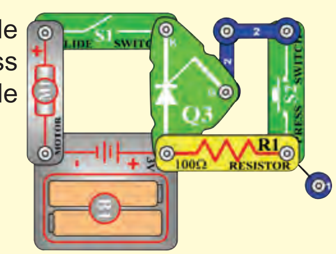
23. **Recording IC (U6):** Build project #308. Make an 8 second recording, then listen to the three prerecorded songs.
24. **Relay (S3):** Build project #341. The red LED (D1) should be on when the slide switch (S1) is on, and the green LED (D2) should be on when the switch is off.
25. **Transformer (T1):** Build the mini-circuit shown here. Pressing the press switch (S2) flashes the green LED (D2). Connect the jumper wire to the CT point. Pressing the press switch flashes the green LED.



26. **Diode (D3):** Build the mini-circuit shown here, the red LED (D1) should light. Reverse the direction of the diode, the LED should not light now.



27. **SCR (Q3):** Build the mini-circuit shown here. Turn on the slide switch (S1) and the motor (M1) should not spin. Press the press switch (S2), the motor should start spinning. Now turn the slide switch off and on, the motor should not spin.



28. **7-Segment Display (D7):** Build project #337. All segments light, displaying the number 8.

MORE DO's and DON'Ts of Building Circuits

After building the circuits given in this booklet, you may wish to experiment on your own. Use the projects in this booklet as a guide, as many important design concepts are introduced throughout them. Every circuit will include a power source (the batteries), a resistance (which might be a resistor, lamp, motor, integrated circuit, etc.), and wiring paths between them and back. You must be careful not to create "short circuits" (very low-resistance paths across the batteries, see examples below) as this will damage components and/or quickly drain your batteries. Only connect the IC's using configurations given in the projects, incorrectly doing so may damage them. **Elenco® is not responsible for parts damaged due to incorrect wiring.**

Here are some important guidelines:

ALWAYS **USE EYE PROTECTION WHEN EXPERIMENTING ON YOUR OWN.**

ALWAYS include at least one component that will limit the current through a circuit, such as the speaker, lamp, whistle chip, capacitors, IC's (which must be connected properly), motor, microphone, photoresistor, or fixed resistors.

ALWAYS use the **7-segment display**, LED's, transistors, the high frequency IC, the **SCR**, the antenna, and switches **in conjunction with other components that will limit the current through them**. Failure to do so will create a short circuit and/or damage those parts.

ALWAYS connect the adjustable resistor so that if set to its 0 setting, the current will be limited by other components in the circuit.

ALWAYS connect position capacitors so that the "+" side gets the higher voltage.

ALWAYS disconnect your batteries immediately and check your wiring if something appears to be getting hot.

ALWAYS check your wiring before turning on a circuit.

ALWAYS **connect IC's, the FM module, and the SCR using configurations given in the projects or as per the connection descriptions for the parts.**

NEVER try to use the high frequency IC as a transistor (the packages are similar, but the parts are different).

NEVER use the 2.5V lamp in a circuit with both battery holders unless you are sure that the voltage across it will be limited.

NEVER connect to an electrical outlet in your home in any way.

NEVER leave a circuit unattended when it is turned on.

NEVER touch the motor when it is spinning at high speed.

Note: If you have the more advanced Model SC-750, there are additional guidelines in your other project manual.

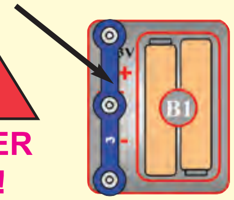
For all of the projects given in this book, the parts may be arranged in different ways without changing the circuit. For example, the order of parts connected in series or in parallel does not matter — what matters is how combinations of these sub-circuits are arranged together.

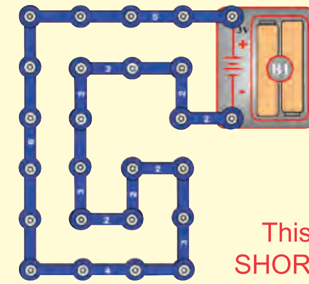
Warning to Snap Rover owners: Do not connect your parts to the Rover body except when using our approved circuits, the Rover body has a higher voltage which could damage your parts.

Examples of SHORT CIRCUITS - NEVER DO THESE!!!

Placing a 3-snap wire directly across the batteries is a SHORT CIRCUIT.

NEVER DO!



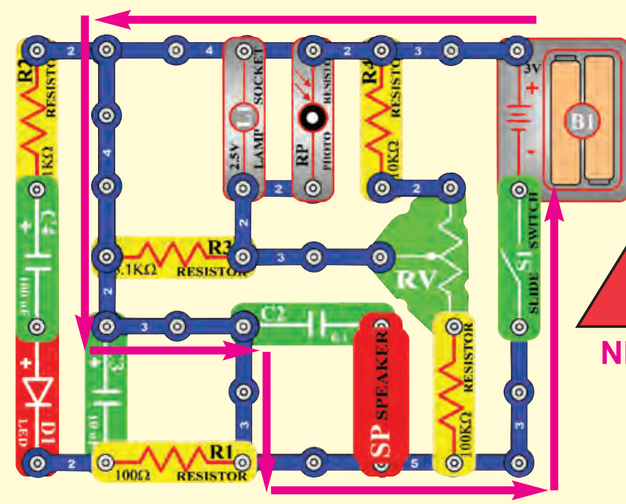


NEVER DO!

This is also a SHORT CIRCUIT.

When the slide switch (S1) is turned on, this large circuit has a SHORT CIRCUIT path (as shown by the arrows). The short circuit prevents any other portions of the circuit from ever working.

NEVER DO!



NEVER DO!

You are encouraged to tell us about new circuits you create. If they are unique, we will post them with your name and state on our website at **www.snapcircuits.net/kidkreations.htm**. Send your suggestions to Elenco®.

Elenco® provides a circuit designer so that you can make your own Snap Circuits® drawings. This Microsoft® Word document can be downloaded from **www.snapcircuits.net/SnapDesigner.doc** or through the **www.snapcircuits.net** web site.

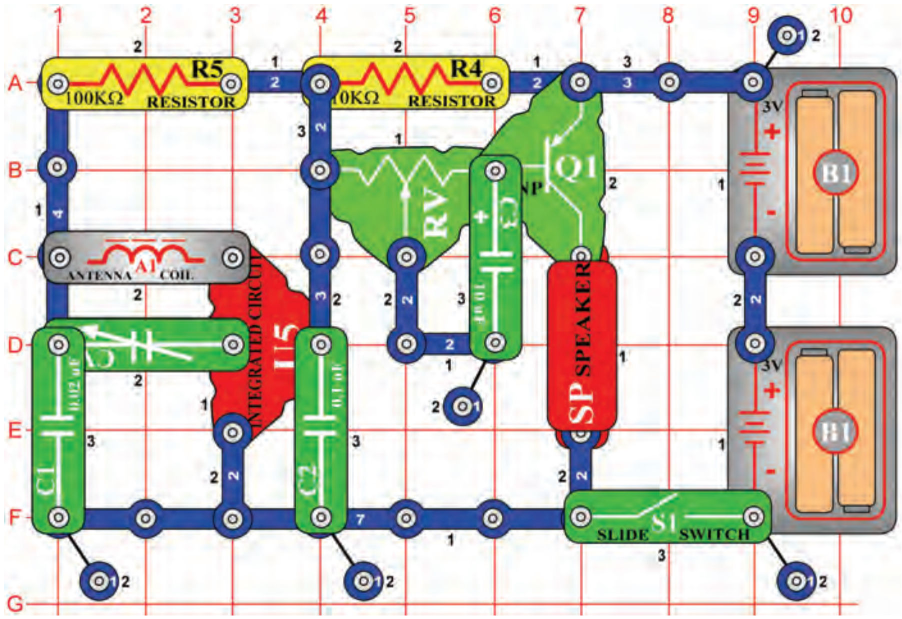
WARNING: SHOCK HAZARD - Never connect Snap Circuits® to the electrical outlets in your home in any way!

Project Listings

Project Listings

☐ Project #306 — AM Radio

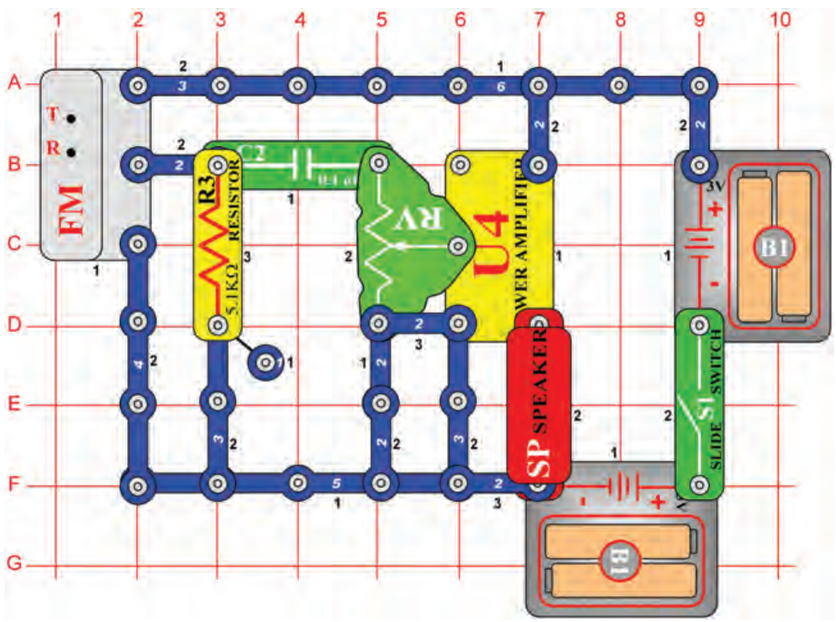
OBJECTIVE: To build a one-IC AM radio.



Turn on the slide switch (S1) and adjust the variable capacitor (CV) for a radio station. Make sure you set the variable resistor (RV) control to the left for louder sound.

☐ Project #307 — Adjustable Volume FM Radio

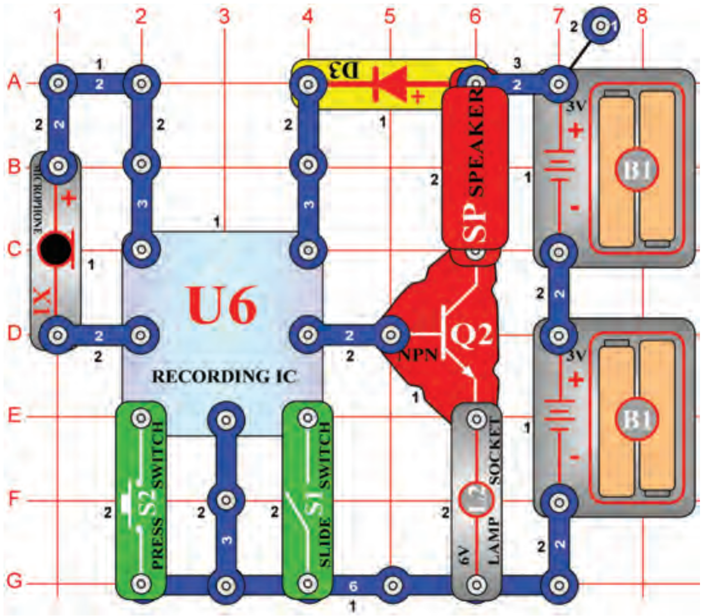
OBJECTIVE: To build a working FM radio with adjustable volume.



Turn on the slide switch (S1) and press the R button. Now press the T button and FM module (FM) scans for a radio station. When a station is found, it locks on to it and you hear it on the speaker (SP). Adjust the volume using the adjustable resistor (RV). The resistor controls the amount of signal into the power amplifier IC (U4). Press the T button again for the next radio station. The module will scan up to 108MHz, the end of the FM band, and stop. You must then press reset (R) to start at 88MHz again.

Project #308

Playback & Record



OBJECTIVE: To demonstrate the capabilities of the recording integrated circuit.

Build the circuit shown. Turn on the slide switch (S1), you hear a beep signaling that you may begin recording. Talk into the microphone (X1) up to 5 seconds, and then turn off the slide switch (it also beeps after the 5 seconds expires).

Press the press switch (S2) for playback. It plays the recording you made followed by one of three songs. If you press the press switch before the song is over, music will stop. You may press the press switch several times to play all three songs. The lamp (L2) is used to limit current and will not light.

Project #309

Playing Music

OBJECTIVE: To play the three built-in songs on the recording IC.

Use the circuit in project #308. Turn on the slide switch (S1), then press the press switch (S2) to start the first song. When the music stops, press the press switch again to hear the second song. When the second song stops, press the press switch again, the third song plays.

Project #310

Light-Controlled Music

OBJECTIVE: To build a circuit that uses light to control the recording IC.

Use the circuit in project #308. Replace the press switch (S2) with the photoresistor (RP), then turn on the slide switch (S1). Turn the music on and off by waving your hand over photoresistor.

Project #311

Touch-Controlled Music

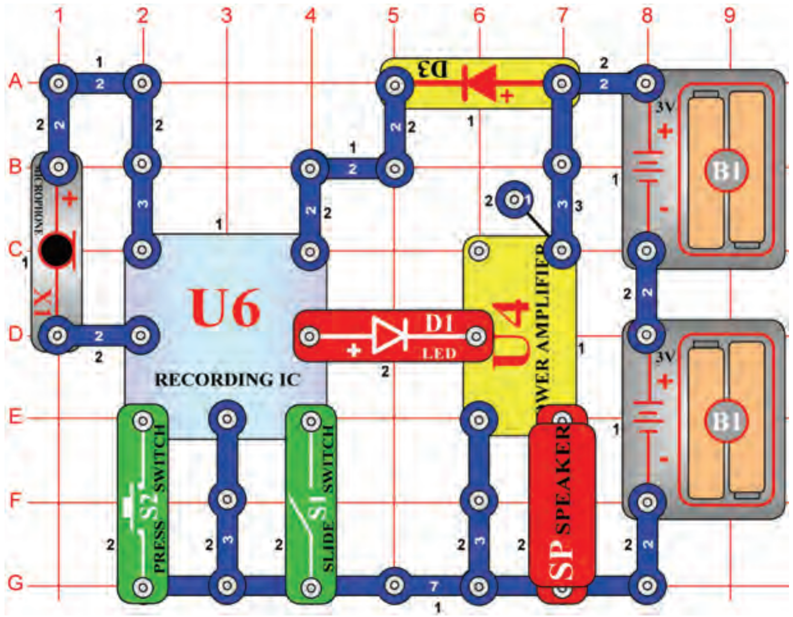
OBJECTIVE: To build a circuit that lets you control the recording IC with your fingers.

Use the circuit in project #308. Place a single snap on base grid point F1. Replace the press switch (S2) with the PNP transistor (Q1, with the arrow on point E2) and then turn on the slide switch (S1). Turn the music on and off by touching points F1 & G2 at the same time. You may need to wet your fingers.

Project #312

Power Playback & Record

OBJECTIVE: To build a circuit that amplifies the recording IC.



Connecting the power amplifier IC (U4) to the output of the recording IC (U6), you can make much louder music than project #308.

Turn on the switch (S1), you hear a beep signaling that you may begin recording. Talk into the microphone up to 5 seconds, and then turn open the switch (it also beeps after the 5 seconds expires).

Press the press switch (S2) for playback. It plays the recording you made followed by one of three songs. If you press switch (S2) before the song is over, music will stop. You may press the press switch several times to play all three songs.

Project #313

Power Amplified Playing Music

OBJECTIVE: To amplify the output of the recording IC.

Use the circuit in project #312. Turn on the switch (S1), then press the press switch (S2) to start the first song. When the music stops, press the press switch again to hear the second song. When the second song stops, press the press switch again, the third song plays.

Project #314

Power Light-Controlled Music

OBJECTIVE: Show variations of project #312.

Use the circuit in project #312. Replace the press switch (S2) with the photoresistor (RP), then turn on the switch (S1). Turn the music on and off by waving your hand over photoresistor.

Project #315

Power Touch-Controlled Music

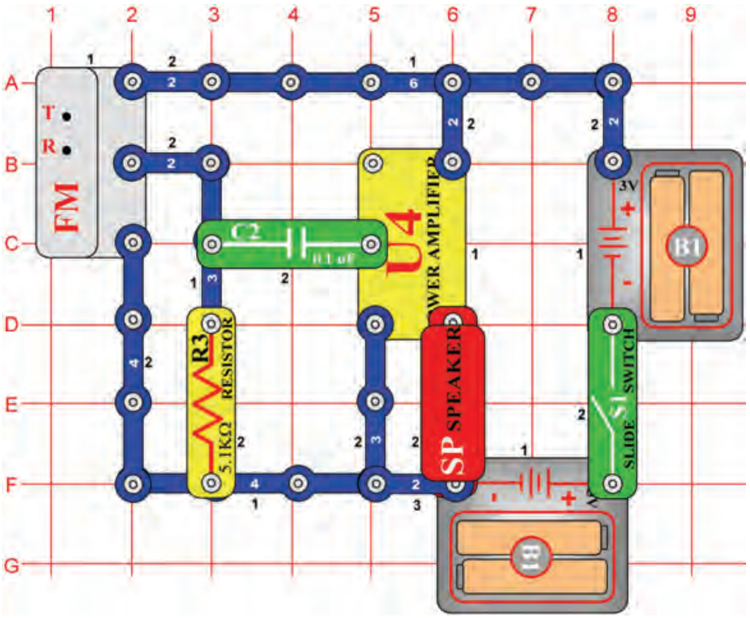
OBJECTIVE: Show variations of project #312.

Use the circuit in project #312. Place a single snap on base grid point F1. Replace the press switch (S2) with the PNP transistor (Q1, with the arrow on point E2) and then turn on the slide switch (S1). Turn the music on and off by touching points F1 & G2 at the same time. You may need to wet your fingers.

Project #316

FM Radio

OBJECTIVE: To build a working FM radio.



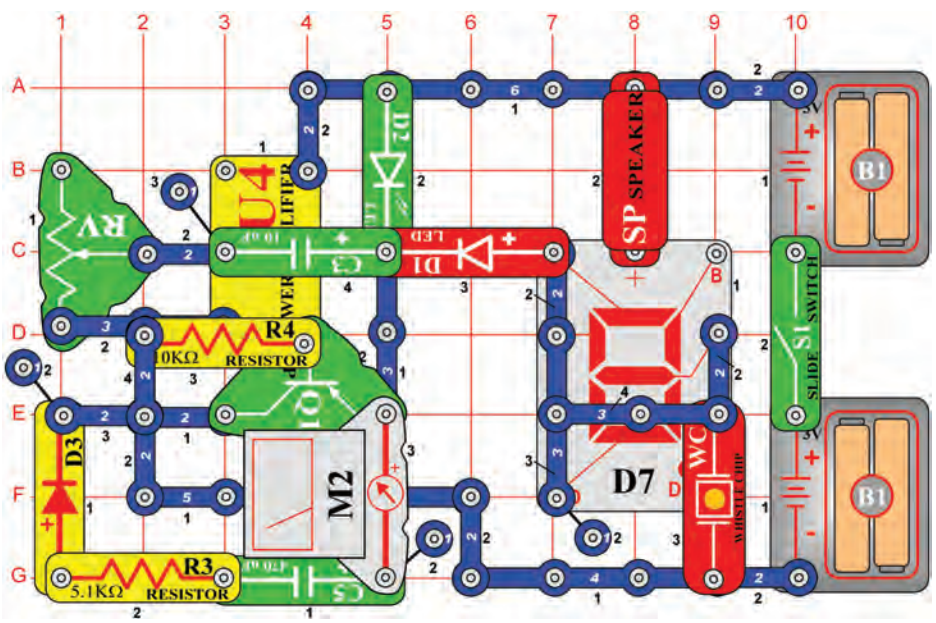
The FM module (FM) contains a scan (T) and a reset (R) button. The R button resets the frequency to 88MHz. This is the beginning of the FM range. Press the T button, the module scans for the next available radio station.

Turn on the slide switch (S1) and press the R button. Now press the T button and the FM module scans for an available radio station. When a station is found, it locks on to it and you hear it on the speaker. Press the T button again for the next radio station. The module will scan up to 108MHz, the end of the FM band, and stop. You must then press the reset (R) button to start at 88MHz again.

Project #317

Mega Circuit

OBJECTIVE: To build a complex circuit.



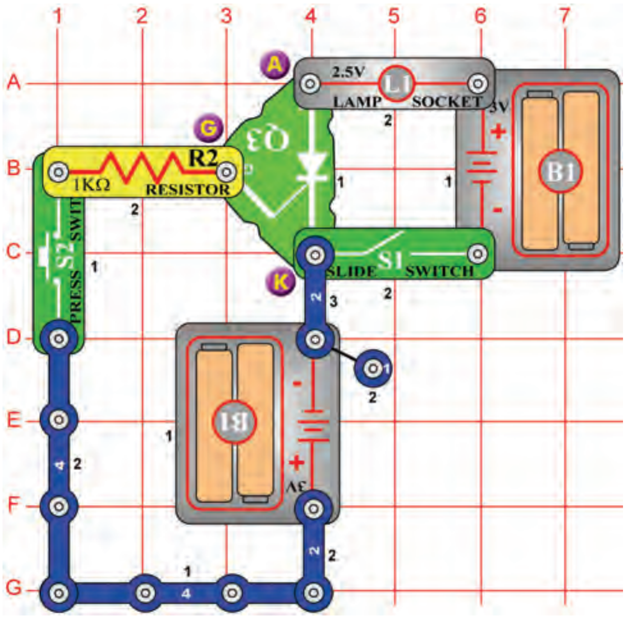
Note that there is a 3-snap wire between RV and U4, partially hidden under R4.

This is an example of using many parts to create an unusual circuit. Set the meter (M2) to the LOW (or 10mA) scale. Turn on the slide switch (S1). As the circuit oscillates, the 7-segment display (D7) flashes the number 5 and the LED's (D1 & D2) flash as well. The meter deflects back and forth and the speaker (SP) sounds a low tone at the same rate. The frequency of the circuit can be changed by adjusting the adjustable resistor (RV).

Next, place the 100Ω resistor (R1) directly over the diode (D3) using a 1-snap. See how this changes the circuit performance.

Project #318 SCR 2.5V Bulb

OBJECTIVE: To learn the principle of an SCR.

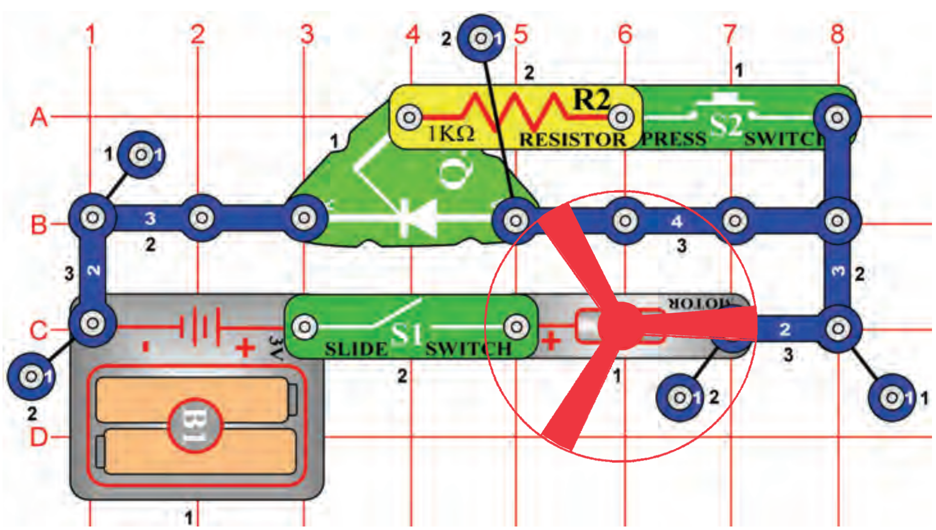


This circuit demonstrates the principle of the SCR (Q3). The SCR can be thought of as an electronic switch with three leads: anode, cathode, and gate. Like a standard diode, it permits current flow in only one direction. It will only conduct in the forward direction when triggered by a short pulse or steady voltage applied between the gate and cathode terminals. One set of batteries powers the lamp, the other is used to trigger the SCR.

Turn on the slide switch (S1) and the bulb (L1) should not light. Now press the press switch (S2); the SCR turns on and lights the bulb. To turn off the bulb you must turn off the slide switch (S1).

Project #319 SCR & Motor

OBJECTIVE: To activate a motor using an SCR.

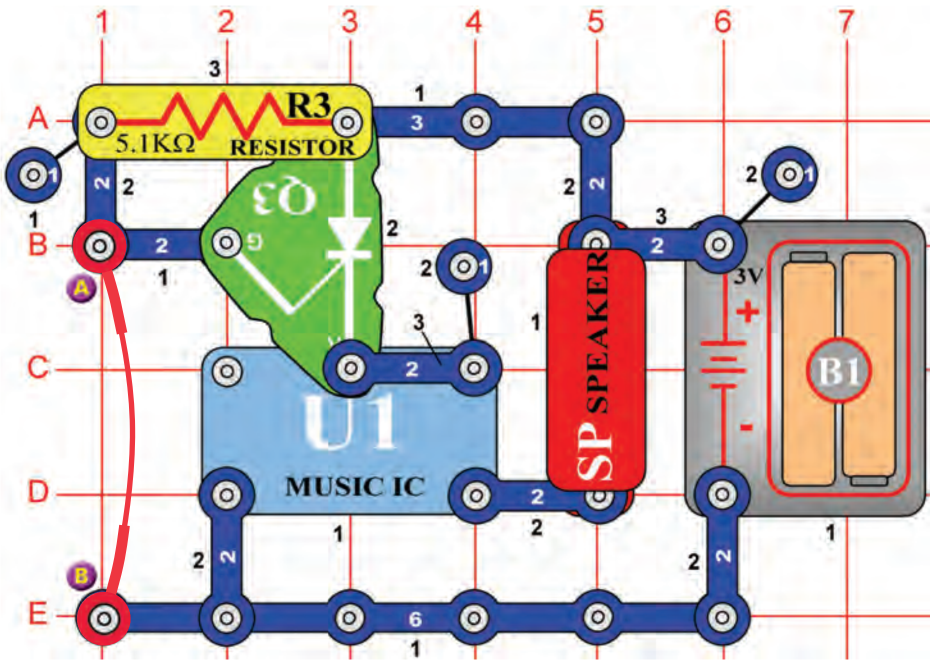


Place the fan onto the motor (M1). In this circuit, the gate is connected to the battery (B1) through the 1KΩ resistor (R2). When the slide switch (S1) is turned on, it triggers the gate, the SCR (Q3) conducts, and the motor spins. The motor continues to spin until the switch is turned off.

WARNING: Moving parts. Do not touch the fan or motor during operation. Do not lean over the motor.

To learn more about how circuits work, visit www.snapcircuits.net or page 62 to find out about our Student Guides.

☐ # Project #320 Music Alarm



OBJECTIVE: To build a music alarm.

The alarm circuit activates when you remove the jumper wire from points A & B. The jumper wire shorts the SCR's (Q3) gate to ground and the SCR does not conduct. Removing the jumper wire places a voltage on the gate and the SCR conducts. This connects the battery to the music IC (U1) and music is played.

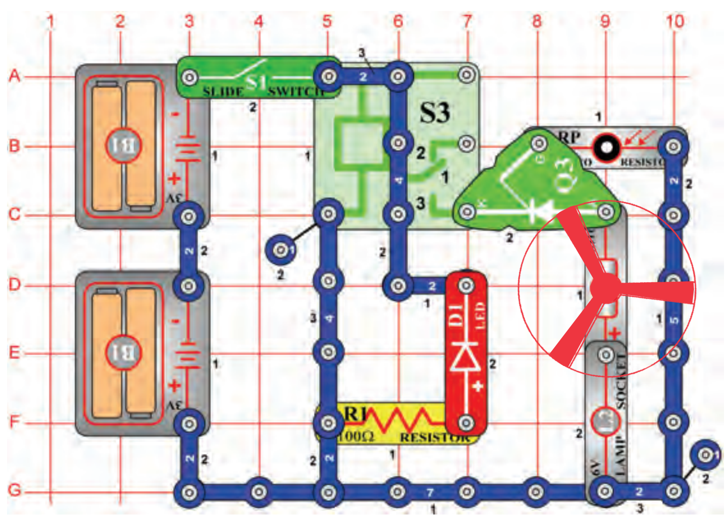
Construct the circuit and you should hear no music. Now remove the jumper wire and the music starts playing.

☐ # Project #321 Light-Music Alarm

OBJECTIVE: To build a light-music alarm.

Use the circuit in project #320. Replace the resistor R3 with the photoresistor (RP) and remove the jumper wire. Cover the photoresistor with your hand. Now slowly remove your hand. When enough light hits the resistor, the music plays.

☐ # Project #322 Light-controlled SCR



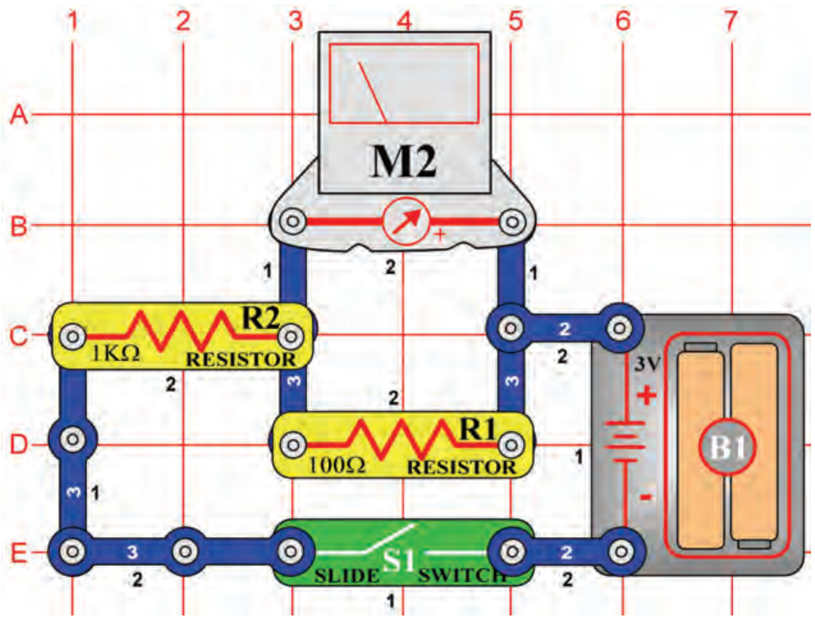
OBJECTIVE: To build a circuit that activates a bulb and motor with the amount of light present.

Cover the photoresistor (RP) with your finger. Turn on the switch (S1), and only the LED (D1) lights. The relay (S3) connects the motor (M1) and the bulb (L2) to the batteries, but the motor and bulb are powerless until a voltage is applied to the SCR's gate.

Remove your finger, as light hits the photoresistor, its resistance decreases and a voltage appears on the gate of the SCR (Q3). The SCR conducts and the motor and bulb work now.

WARNING: Moving parts. Do not touch the fan or motor during operation. Do not lean over the motor.

Project #323 — 3mA Meter

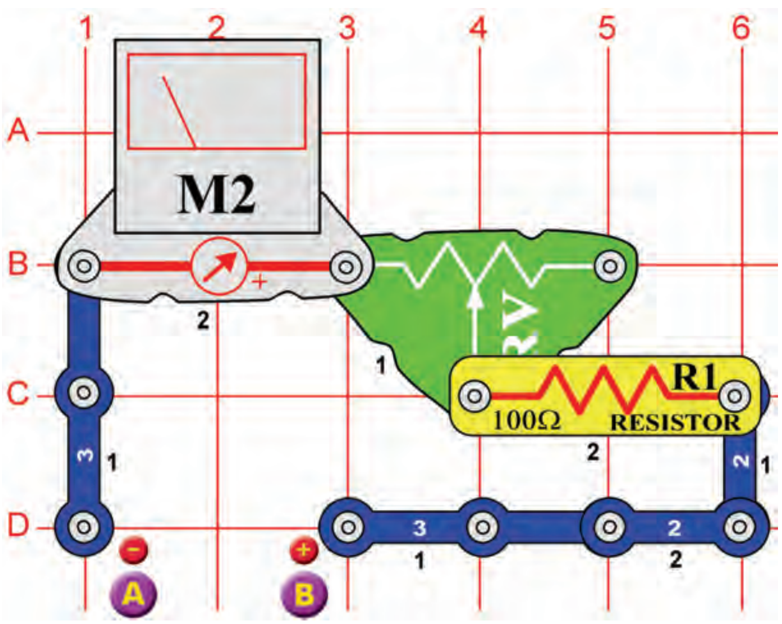


OBJECTIVE: To build a 3mA meter circuit.

Set the meter (M2) to the LOW (or 10mA) scale. Inside the meter, there is a fixed magnet and a moveable coil around it. As current flows through the coil, it creates a magnetic field. The interaction of the two magnetic fields cause the coil (connected to the pointer) to move (deflect). By itself, the meter can measure 300μA. To increase its range, resistors are connected in parallel or in series to the meter.

Build the circuit shown. Placing the 100Ω resistor (R1) in parallel with the meter increases the range by 10 times to 3mA. More current flows through the resistor than the meter. The lower the resistor value, the wider the range of the meter.

Project #324 — 0-3V Voltmeter



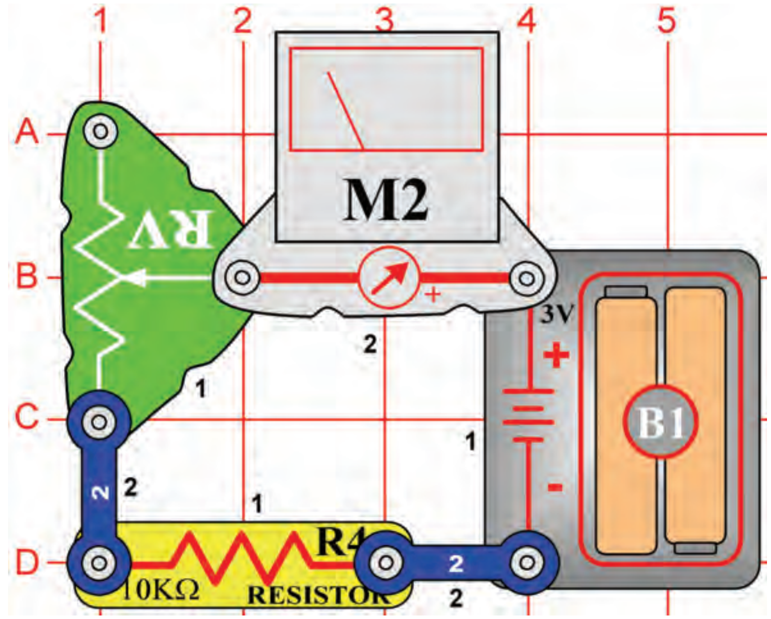
OBJECTIVE: To build a voltmeter.

Build this 0-3V voltmeter circuit. Set the meter (M2) to the LOW (or 10mA) setting. Using new batteries, place the battery holder between points A & B. Adjust the adjustable resistor (RV) so the meter deflects full scale.

Now you can check your other "AA" batteries by inserting them into the battery holder.

Project #325

Function of Adjustable Resistor



OBJECTIVE: To understand the function of the adjustable resistor.

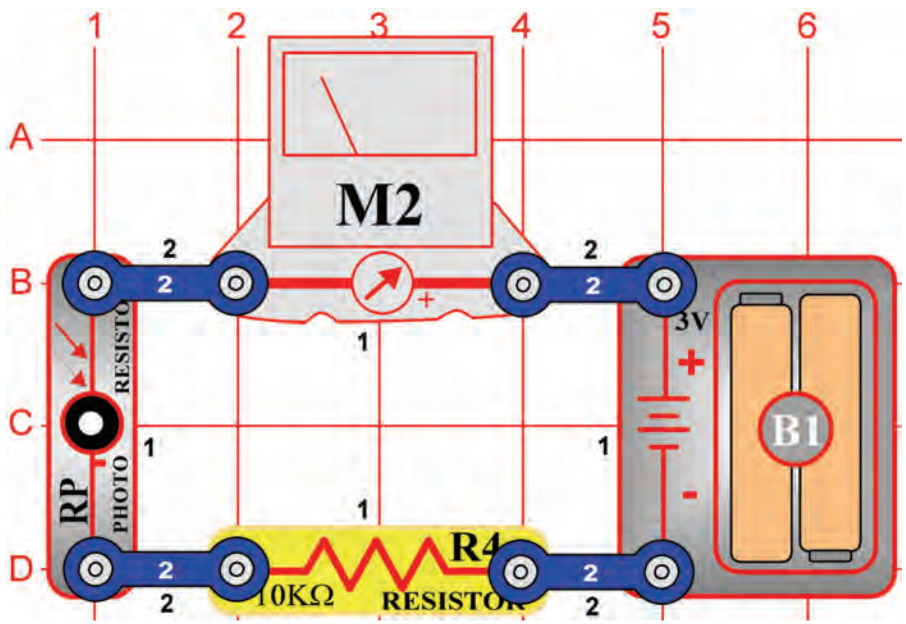
An adjustable resistor is a normal resistor with an additional arm contact. The arm moves along the resistive material and taps off the desired resistance.

The slider on the adjustable resistor moves the arm contact and sets the resistance between the bottom (point C1) pin and the center pin (point B2). The remaining resistance is between the center and top pin. For example, when the slider is all the way down, there is minimal resistance between the bottom and center pins (usually 0Ω) and maximum resistance between the center and top pins. The resistance between the top (point A1) and bottom (point A3) pins will always be the total resistance, (50kΩ for your part).

Set the meter (M2) to the LOW (or 10mA) scale. Adjust the adjustable resistor (RV) for maximum resistance by setting the slider to the top. The meter only deflects part of the way. As you move the slider down, decreasing the resistance, the meter deflects more.

Project #326

Function of photoresistor

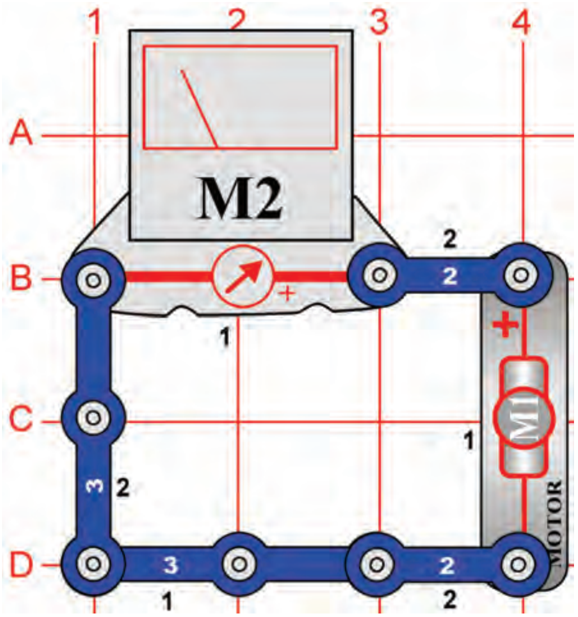


OBJECTIVE: To understand the function of the photoresistor.

Build the circuit shown. Set the meter (M2) to the LOW (or 10mA) scale. The photoresistor (RP) is a light-sensitive resistor. Its value changes from nearly infinite in total darkness to about 1,000Ω when a bright light shines on it.

The meter reading changes as the resistance changes in the circuit. When the lights are on, the meter points to a higher number on the scale. When the lights are OFF, the pointer will point to a lower number on the scale. This means that the resistance of the photoresistor is changing according to the amount of light in the room.

Project #327

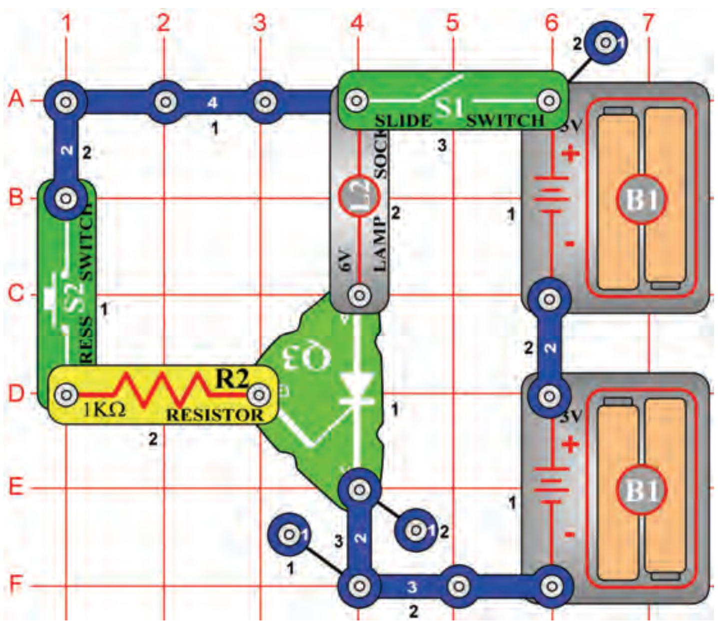


Meter Deflect by Motor

OBJECTIVE: To change the direction of current flow using a motor.

Set the meter (M2) to the LOW (or 10mA) setting. A motor generates a current when it rotates. The rotation of the motor determines the direction current flows. Quickly spin the motor (M1) clockwise with your hand; the meter deflects to the right. Now spin the motor counterclockwise, and the meter deflects to the left.

Project #328

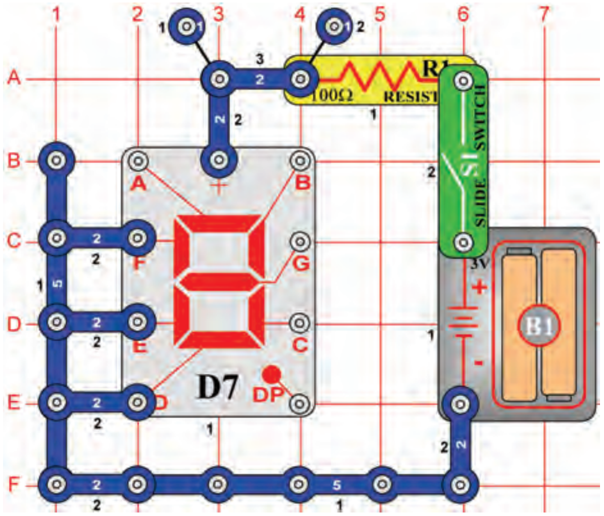


SCR 6V Bulb

OBJECTIVE: To learn the principle of an SCR.

In this circuit, the 6-volt bulb (L2) will not light until the SCR (Q3) is triggered. Turn on the slide switch (S1) and the bulb will not light. Now press the press switch (S2) to light the bulb. The bulb will stay lit until the slide switch is turned off. To protect the SCR, a current limiting 1kΩ resistor (R2) is placed in series with the gate.

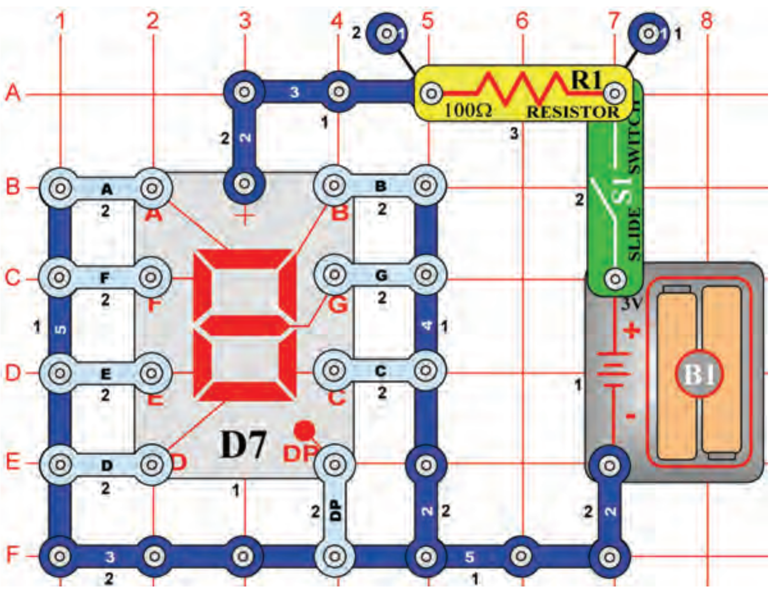
Project #329



Principle of Segment LED

OBJECTIVE: To demonstrate how a seven segment LED works.

The display (D7) is made up of seven segments. Each segment contains an LED connected to an input snap. When the snap is connected to the negative of the battery the segment lights. For example, connect the circuit as shown and the letter “L” lights.



Project #330
Display #1

OBJECTIVE: To configure the seven segment to display the number 1.

Connect B & C to the negative of the battery.

Project #331
Display #2

OBJECTIVE: To configure the seven segment to display the number 2.

Connect A, B, G, E, & D to the negative of the battery.

Project #332
Display #3

OBJECTIVE: To configure the seven segment to display the number 3.

Connect A, B, G, C, & D to the negative of the battery.

Project #333
Display #4

OBJECTIVE: To configure the seven segment to display the number 4.

Connect B, C, F, & G to the negative of the battery.

Project #334
Display #5

***OBJECTIVE:** To configure the seven segment to display the number 5.*

Connect A, F, G, C, & D to the negative of the battery.

Project #335
Display #6

***OBJECTIVE:** To configure the seven segment to display the number 6.*

Connect A, C, D, E, F, & G to the negative of the battery.

Project #336
Display #7

***OBJECTIVE:** To configure the seven segment to display the number 7.*

Connect A, B, & C to the negative of the battery.

Project #337
Display #8

***OBJECTIVE:** To configure the seven segment to display the number 8.*

Connect A, B, C, D, E, F & G to the negative of the battery.

Project #338
Display #9

***OBJECTIVE:** To configure the seven segment to display the number 9.*

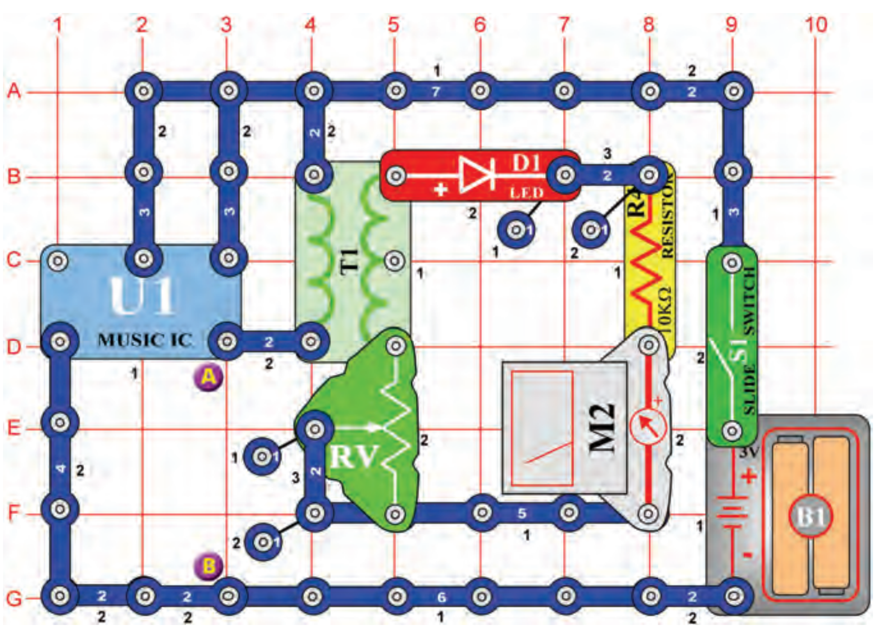
Connect A, B, C, D, F, & G to the negative of the battery.

Project #339
Display #0

***OBJECTIVE:** To configure the seven segment to display the number 0.*

Connect A, B, C, D, E, & F to the negative of the battery.

Project #340 Music Meter



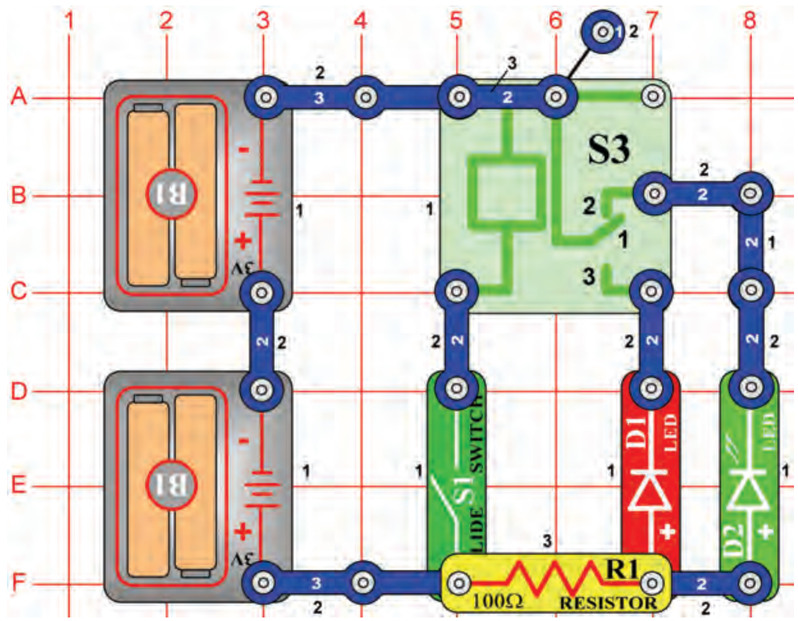
***OBJECTIVE:** See and hear the output of the music IC.*

Set the meter (M2) to the LOW (or 10mA) setting. In this circuit, the output of the music IC (U1) is applied to the less windings side of the transformer (T1), which lights the LED (D1) and deflects the meter.

Place the adjustable resistor (RV) to the bottom position and turn on the switch (S1). Adjust the adjustable resistor upwards. This increases the voltage across the LED and meter. The LED brightens and the meter deflects more towards 10. Place the speaker (SP) across points A & B and use a jumper wire to complete the connection. Now you can hear and see the output of the music IC.

Project #341 LED & Relay

OBJECTIVE: Turn on and off LED's using a relay.

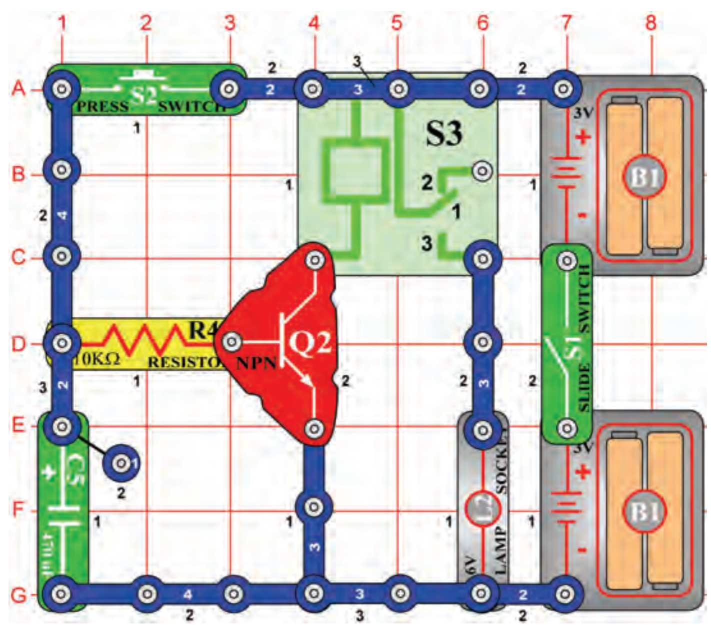


A relay is an electronic switch with contacts that are opened or closed using voltage. It contains a coil that generates a magnetic field when a current flows through it. The magnetic field attracts an iron armature which switches the contacts. Contact #2 is normally closed, connecting the green LED (D2) and the resistor across the batteries.

With the slide slide switch (S1) turned off, the green LED should light. Now turn on the switch, contact #1 on the relay (S3) will switch to contact #3, lighting the red LED (D1).

Project #342 Manual 7 Second Timer

OBJECTIVE: To build a manual timer using a relay.

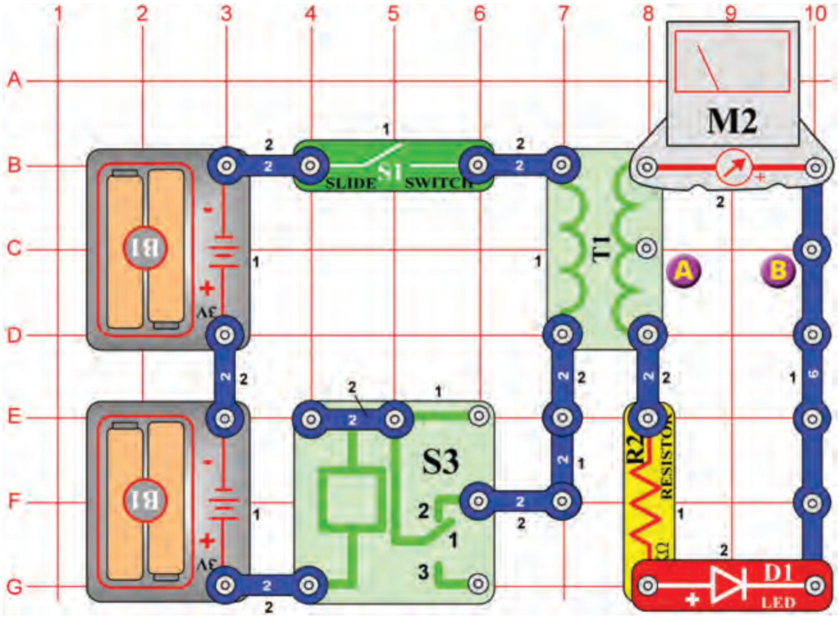


The transistor (Q2) acts as a switch, connecting the relay (S3) to the batteries. As long as there is positive voltage on the transistor's base, the bulb (L2) will light.

Turn on the slide switch (S1) and hold down the press switch (S2). The transistor turns on, capacitor C5 charges up, and the bulb lights. When the press switch is released, the capacitor discharges through the base, keeping the transistor on. The transistor will turn off when the capacitor is almost discharged, about 7 seconds. The relay contacts will switch and the bulb will turn off.

Change the value of the capacitor and see what happens.

☐ Project #343



Half Wave Rectifier Circuit

OBJECTIVE: To build a half wave rectifier circuit.

A rectifier changes an AC voltage into a DC voltage. A diode (D1) is used because it allows current to flow in only one direction, for one polarity of applied voltage. As the contacts open and close, it generates an AC voltage across the transformer (T1). We can measure the DC current from the transformer's output using a resistor (R2), a diode (D1), and a meter (M2). Set the meter to the LOW (or 10mA) scale. Turn on the slide switch (S1), the LED lights as the meter points past the 5 scale.

☐ Project #344

Half Wave Rectifier Circuit (II)

OBJECTIVE: Measure the voltage using the center-tap.

Use the circuit in project #343. Now see what happens if you connect to the center-tap on the side with more windings. Place the meter (M2) across points A & B, then turn on the switch (S1). The needle should deflect less, about half as much as project #343. As you use less windings, the output decreases.

☐ Project #345

LED vs. Diode

OBJECTIVE: To see the voltage difference between an LED and diode.

Use the circuit in project #343. Replace the LED (D1) with the diode (D3) and turn on the switch (S1). The needle deflects higher, because the voltage drop across the diode is less than the voltage drop across the LED.

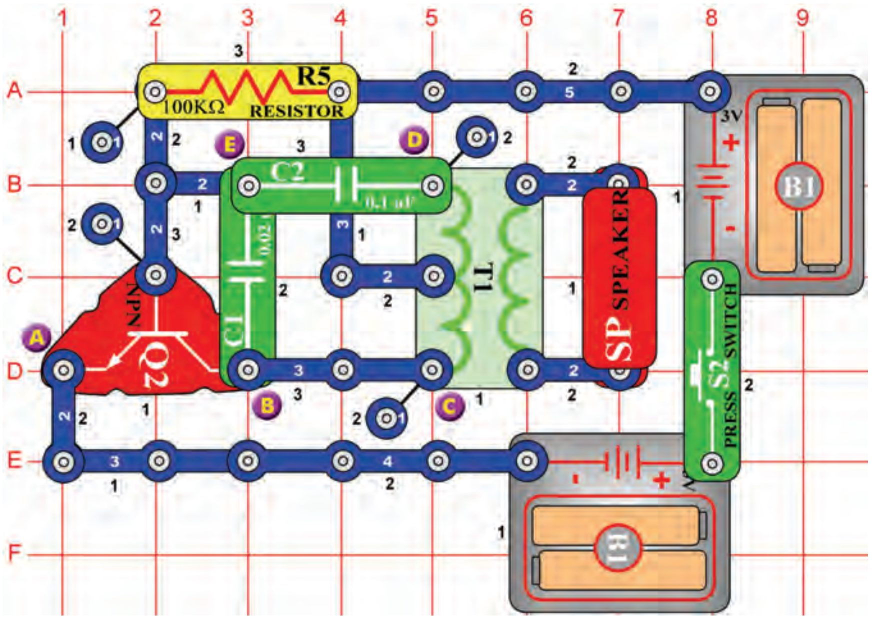
☐ Project #346

Current & Resistance

OBJECTIVE: See how resistance affects current.

Change the 1kΩ (R2) resistor to a 5.1kΩ (R3) and turn on the switch (S1). You will see that increasing the resistance decreases the current through the meter (M2).

Project #347 Telegraph



OBJECTIVE: Making telegraph sounds.

Press the press switch (S2) down. The circuit oscillates and the AC voltage generated from the transformer (T1) drives the speaker (SP). To make a telegraph sound, depress the switch for long and short periods.

Project #348 Mosquito Sound

OBJECTIVE: Use the whistle chip to make a mosquito sound.

Use the circuit in project #347. Remove the speaker (SP). Connect the whistle chip (WC) across points C & D to make a mosquito sound.

Project #349 Mosquito Sound (II)

OBJECTIVE: Show variations of project #347.

Use the circuit in project #347. Connect the whistle chip (WC) across points B & E.

Project #350 Mosquito Sound (III)

OBJECTIVE: Show variations of project #347.

Use the circuit in project #347. Connect the whistle chip (WC) across points E & D (place it beneath capacitor (C2) or use the jumper wires).

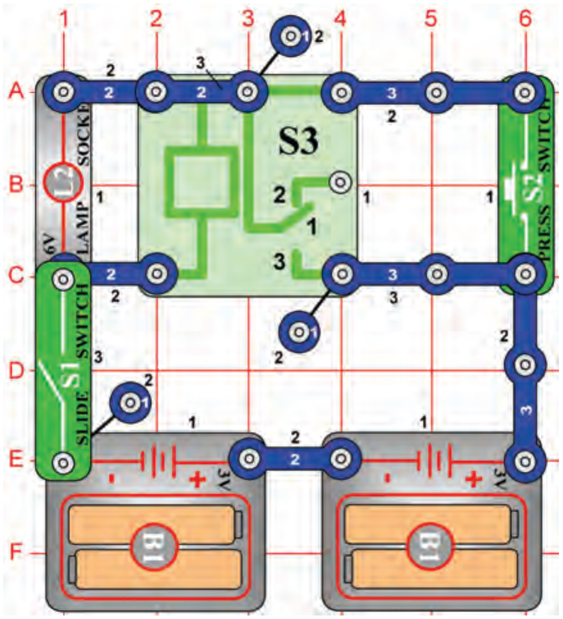
Project #351 Touch-Control Mosquito Sound

OBJECTIVE: To use the photoresistor to adjust the oscillator sound.

Use the circuit in project #347. Replace the 100kΩ resistor (R5) with the photoresistor (RP). Wave your hand over the resistor and the sound changes.

☐
Project #352 Bulb & Relay

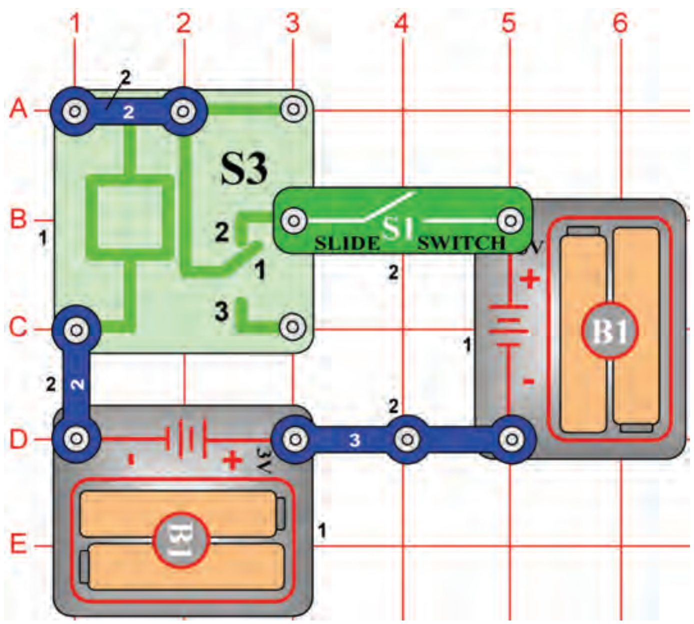
OBJECTIVE: Light a bulb using a relay.



Turn off the slide switch (S1). If you press switch (S2), the lamp (L2) will not light. Turn on the slide switch and press the press switch again; the lamp lights and stays on until the slide switch is turned off. This circuit remembers that the press switch was pressed. Turn the slide switch off and back on again. The lamp will be off until the press switch is pressed, then the lamp will stay on. Computers use memory circuits to remember states like on and off.

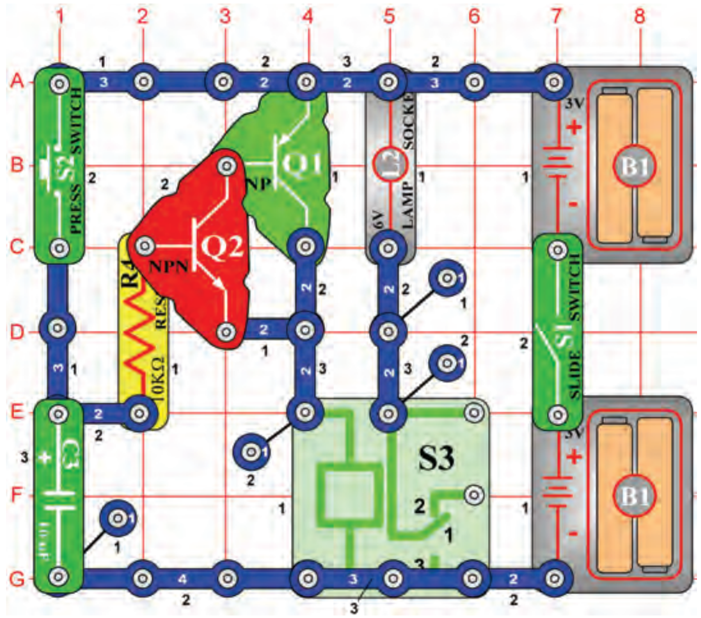
☐
Project #353 Relay Buzzer

OBJECTIVE: To make a relay buzzer.



When you turn on the switch (S1), you should hear a buzzing sound from the relay (S3). The sound is caused by the relay's contacts opening and closing at a fast rate.

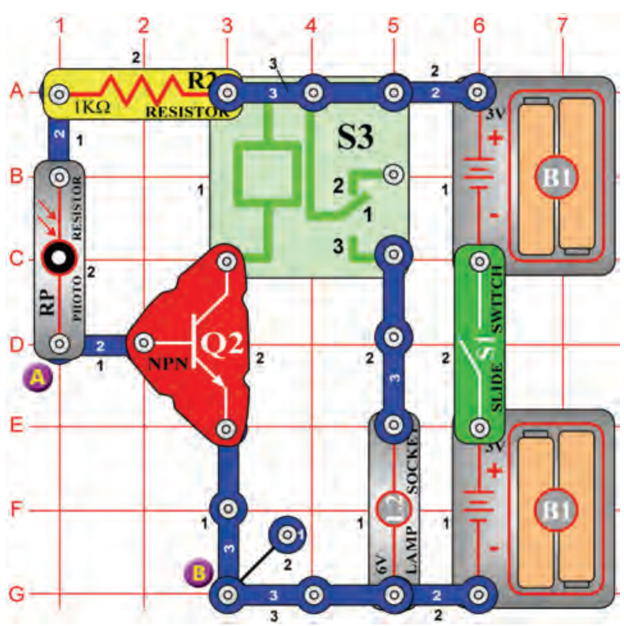
☐ Project #354 — Transistor Timer



OBJECTIVE: To build a manual timer using a transistor in place of the relay.

This circuit is similar to project #342 except now two transistors are used. Turn on the slide switch (S1) and hold down the press switch (S2). The transistors (Q1 & Q2) turn on, the capacitor (C3) charges up, and the bulb (L2) lights. When the press switch (S2) is released, the capacitor discharges through the base, keeping the transistors on. The transistors will turn off when the capacitor is almost discharged (about 1 minute). The relay (S3) contacts will switch and the bulb will turn off.

☐ Project #355 — Light-controlled Relay



OBJECTIVE: To use a photoresistor to control a relay.

Under normal light, the resistance of the photoresistor (RP) is low, allowing a voltage at the base of the transistor (Q2). This turns the transistor on, connecting the relay (S3) across the batteries, and the bulb (L2) lights. If the light decreases, the resistance increases and the voltage to Q2 drops. If the voltage at Q2 decreases enough, the transistor turns off.

Turn on the slide switch (S1) and the bulb lights. Now as you block the light from the photoresistor, the bulb turns off.

☐ Project #356 — Bulb Alert Relay

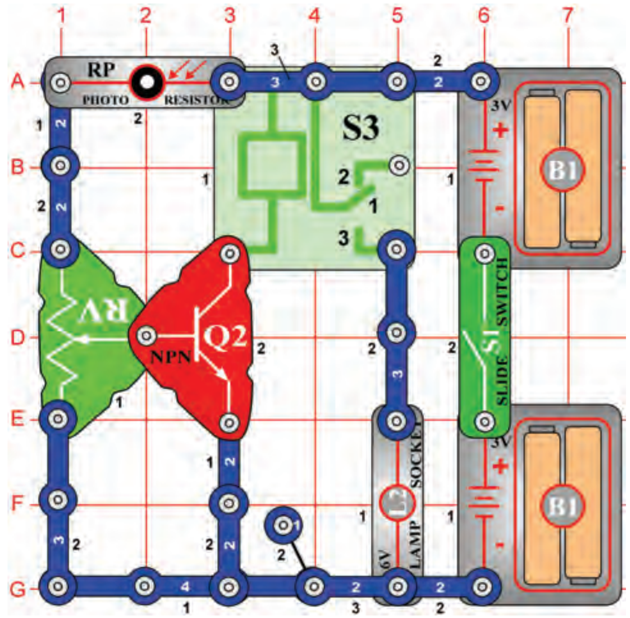
OBJECTIVE: Make a warning system that lights the bulb.

Replace the photoresistor (RP) with a 10kΩ resistor (R4). Connect the wire to points A & B. As long as the wire is connected, the transistor (Q2) is off and the relay (S3) and bulb (L2) are not powered. Disconnect the wire. The relay contacts will switch and the bulb will light.

Project #357

Adjustable Light Control

OBJECTIVE: Build an adjustable light-controlled relay.

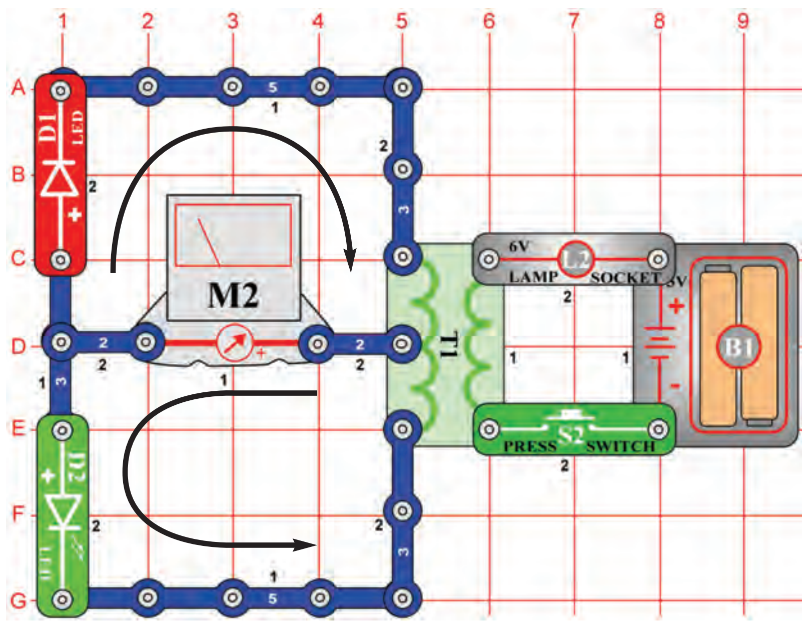


You can set the amount of light it takes to keep the bulb (L2) on by adjusting the adjustable resistor (RV). Set the adjustable resistor to the top position and turn on the switch. The bulb lights. Cover the photoresistor (RP) and the bulb turns off. Set the adjustable resistor to different positions and then cover the photoresistor. Note that only the top half of the adjustable resistor affects the circuit. If you position it below the middle, the bulb stays off.

Project #358

Meter Deflection

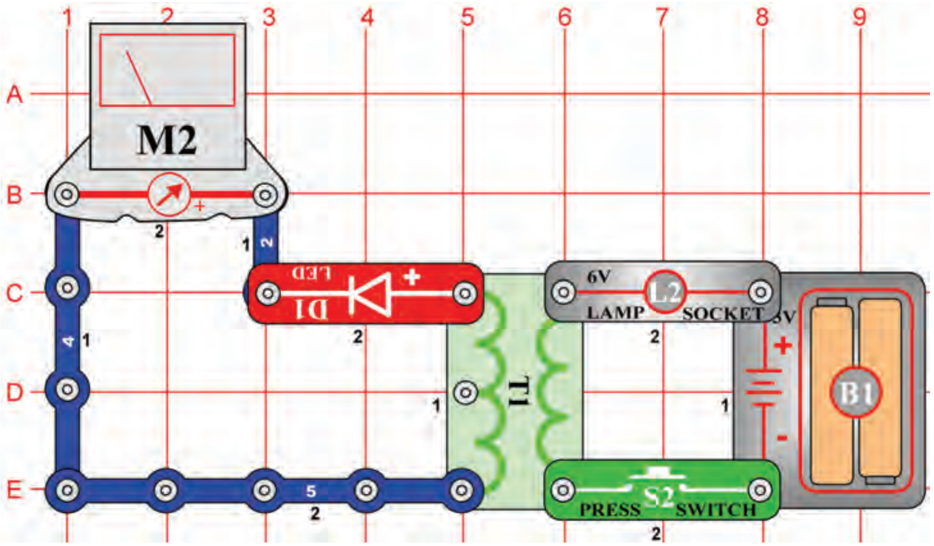
OBJECTIVE: To demonstrate the properties of a transformer.



Set the meter (M2) to the LOW (or 10mA) scale. Pressing the press switch (S2) generates a current on the left side of the transformer (T1). The current lights the LED's (D1 & D2) and deflects the meter. There are two current paths as shown by the arrows. Placing the meter in both current paths always measures each current. The top current is produced when the press switch is pressed and the bottom current is produced when the press switch is released.

Project #359 AC to DC Current

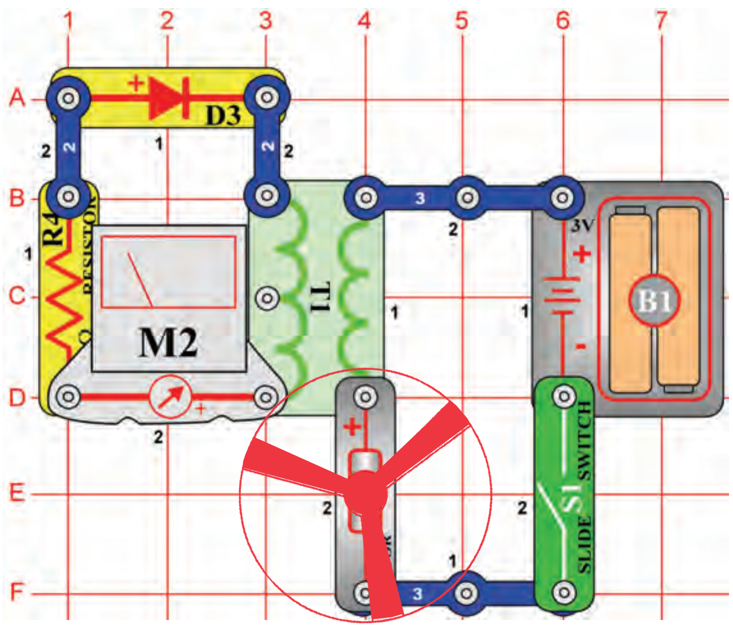
OBJECTIVE: To convert an AC current to DC using an LED.



Set the meter (M2) to the LOW (or 10mA) scale. Pressing and releasing the press switch (S2) continuously generates an AC (changing) current. The LED (D1) is used to convert the AC (changing) current to DC (unchanging) current because it only allows the current to flow in one direction. The LED should light as the meter deflects to the right only. Without the LED, the meter would deflect in both directions.

Project #360 Current Meter

OBJECTIVE: To measure the current through a transformer.



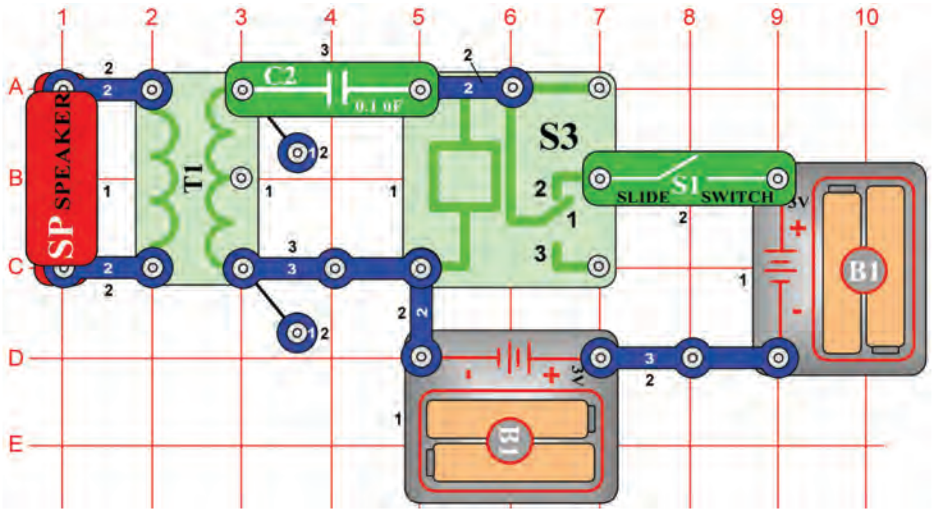
Set the meter (M2) to the LOW (or 10mA) setting. By placing the meter, diode (D3) and current limiting resistor (R4) on the transformer (T1), you can measure the current. Turn on the slide slide switch (S1) and the motor (M1) starts spinning. The current on the right side of the transformer creates a current on the left side using magnetism.

WARNING: Moving parts. Do not touch the fan or motor during operation. Do not lean over the motor.

☐ Project #361

Buzzer, Relay, & Transformer

OBJECTIVE: To use a transformer for a louder buzzer.



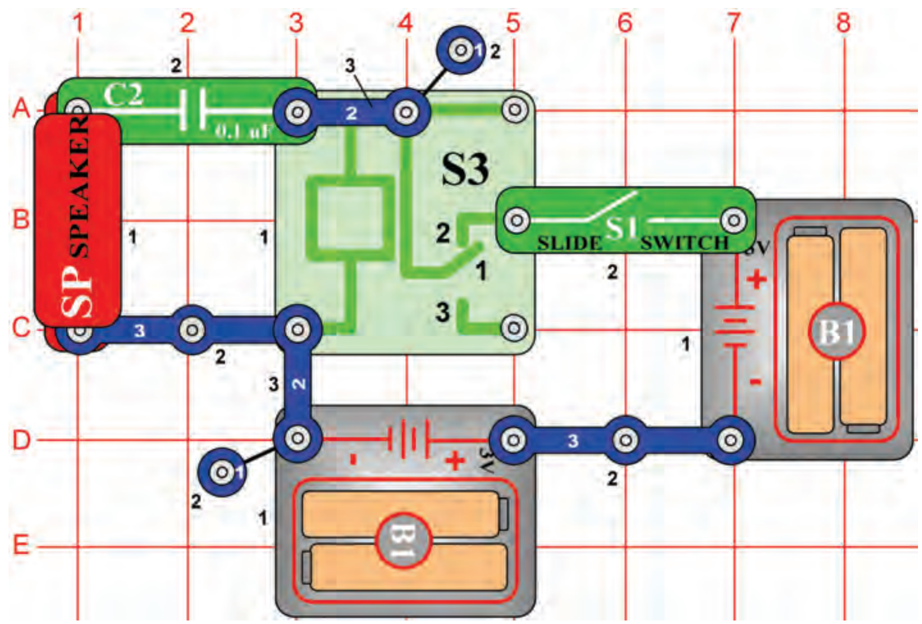
Turn on the switch (S1). The speaker (SP) generates a buzzer sound. As in project #353, the relay (S3) is rapidly switched on and off. This causes an AC voltage on the left side of the transformer (T1). The voltage is stepped-down and applied to the speaker, generating the sound.

To make the sound a little louder, replace the 0.1μF capacitor (C2) with a 3-snap wire.

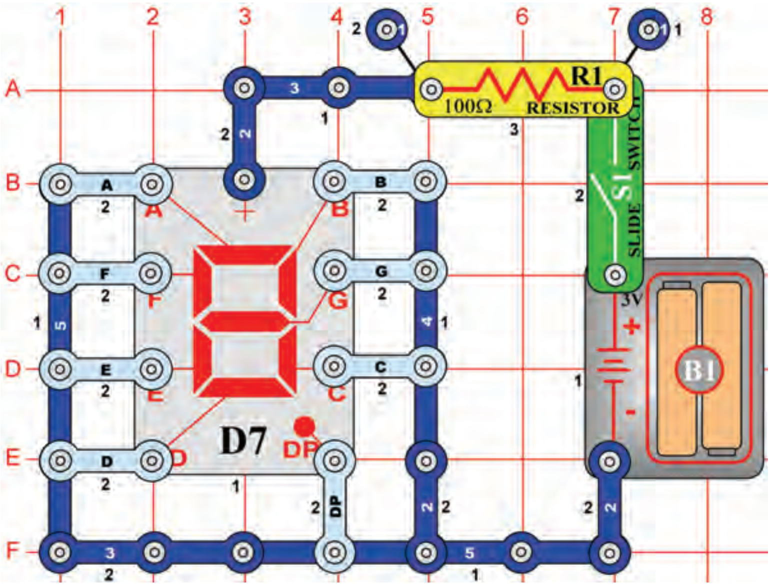
☐ Project #362

Buzzer & Relay

OBJECTIVE: Make a relay buzzer with speaker.



A speaker (SP) and capacitor (C2) are placed across the coil of the relay (S3). When the slide switch (S1) is turned on, the relay's contacts open and close as in project #353. As the capacitor (C2) charges and discharges, the speaker generates a buzzing sound.



☐ Project #363

Display Capital Letter "F"

OBJECTIVE: To configure the seven segment to display the capital letter "F".

Connect A, E, F, & G to the negative of the battery.

☐ Project #364

Display Capital Letter "H"

OBJECTIVE: To configure the seven segment to display the capital letter "H".

Connect B, C, E, F, & G to the negative of the battery.

☐ Project #365

Display Capital Letter "P"

OBJECTIVE: To configure the seven segment to display the capital letter "P".

Connect A, B, E, F, & G to the negative of the battery.

☐ Project #366

Display Capital Letter "S"

OBJECTIVE: To configure the seven segment to display the capital letter "S".

Connect A, F, G, C, & D to the negative of the battery.

☐ Project #367

Display Capital Letter "U"

OBJECTIVE: To configure the seven segment to display the capital letter "U".

Connect B, C, D, E, & F to the negative of the battery.

☐ Project #368

Display Capital Letter "C"

OBJECTIVE: To configure the seven segment to display the capital letter "C".

Connect A, D, E, & F to the negative of the battery.

☐ Project #369

Display Capital Letter "E"

OBJECTIVE: To configure the seven segment to display the capital letter "E".

Connect A, D, E, F, & G to the negative of the battery.

☐ Project #370

Display "."

OBJECTIVE: To configure the seven segment to display the decimal (DP).

Connect DP to the negative of the battery.

☐ **Project #371**

Display Letter "b"

OBJECTIVE: To configure the seven segment to display the letter "b".

Connect C, D, E, F, & G to the negative of the battery.

☐ **Project #372**

Display Letter "c"

OBJECTIVE: To configure the seven segment to display the letter "c".

Connect A, F, & G to the negative of the battery.

☐ **Project #373**

Display Letter "d"

OBJECTIVE: To configure the seven segment to display the letter "d".

Connect B, C, D, E, & G to the negative of the battery.

☐ **Project #374**

Display Letter "e"

OBJECTIVE: To configure the seven segment to display the letter "e".

Connect A, B, D, E, F, & G to the negative of the battery.

☐ **Project #375**

Display Letter "h"

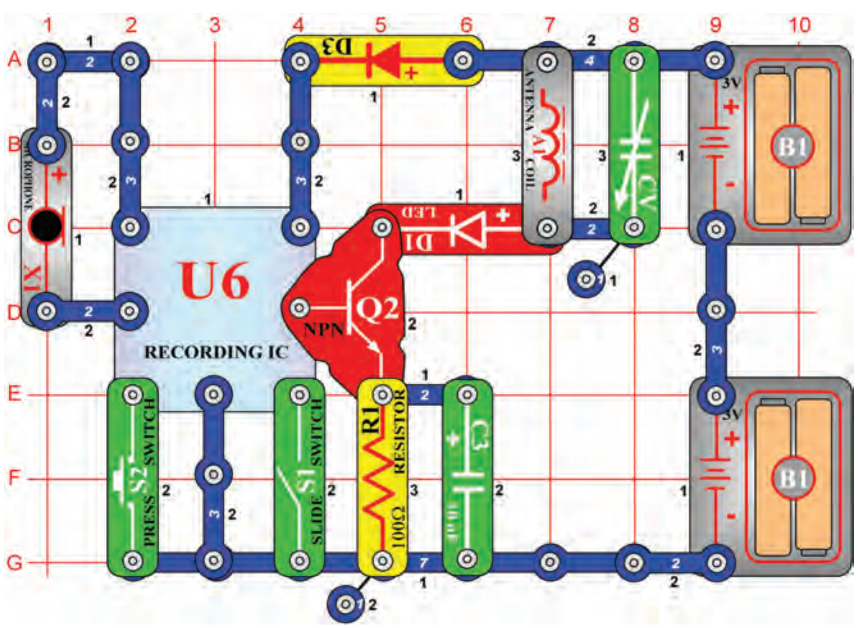
OBJECTIVE: To configure the seven segment to display the letter "h".

Connect F, E, G, & C to the negative of the battery.

☐ **Project #376**

Recorded Voice Transmitter

OBJECTIVE: To hear your voice on the radio.

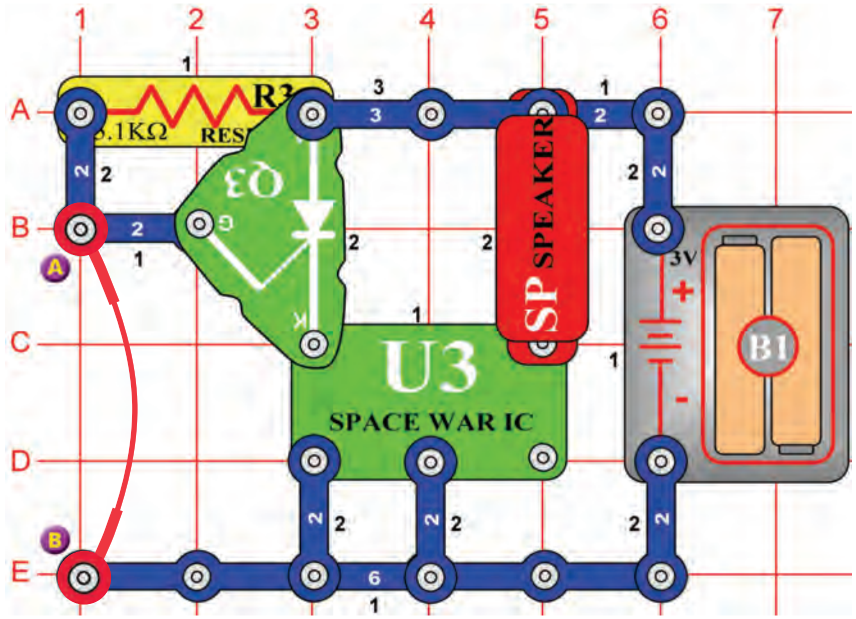


You need an AM radio for this project. Build the circuit shown and place it next to your AM radio. Tune the radio frequency to where no other station is transmitting. Push the press switch (S2); the red LED (D1) should light for a while, indicating that music is being transmitted to your radio. Tune the adjustable capacitor (CV) and the radio volume control until the music sounds best on the radio. Wait until the music stops.

Turn on the slide switch (S1), you hear a beep signaling that you may begin recording. Talk into the microphone (X1) up to 8 seconds, and then turn off the slide switch (it also beeps after the 8 seconds expires).

Press the press switch (S2) for playback. It plays the recording you made followed by one of three songs. If you press the press switch before the song is over, music will stop. You may press the press switch several times to play all three songs.

☐ # Project #377 — Space War Alarm by SCR



OBJECTIVE: To build an alarm circuit.

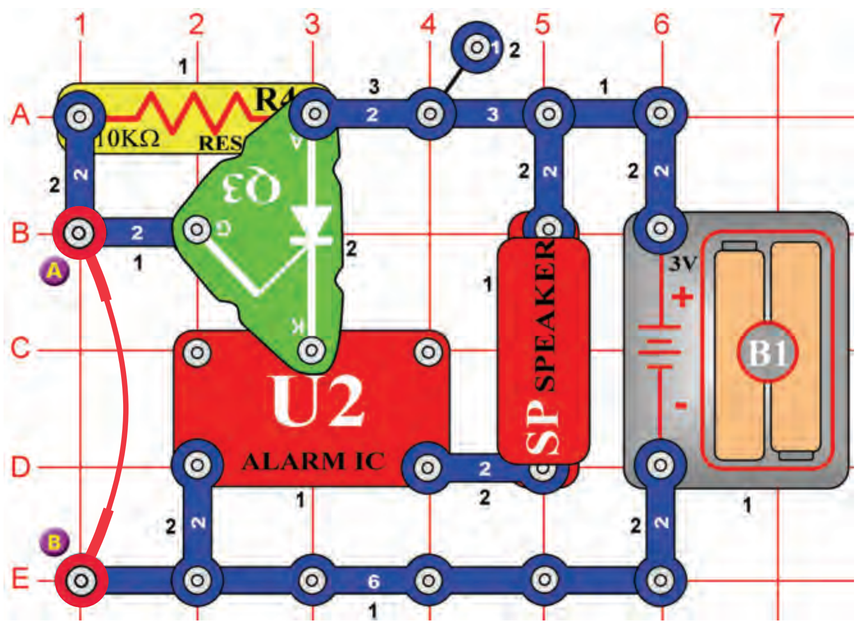
The circuit uses the space war IC (U3) and works the same way as project #320. Remove the jumper wire and a space war sound plays.

☐ # Project #378 — Light Space War Alarm

OBJECTIVE: To build an alarm circuit.

Use the circuit in project #377. Replace the resistor (R3) with the photoresistor (RP) and remove the jumper wire. Cover the photoresistor with your hand. Now slowly remove your hand. The music plays when enough light hits the resistor.

☐ # Project #379 — Alarm by SCR



OBJECTIVE: To build an alarm circuit.

The circuit uses the alarm IC (U2) and works the same way as project #377. Remove the jumper wire and an alarm IC sounds.

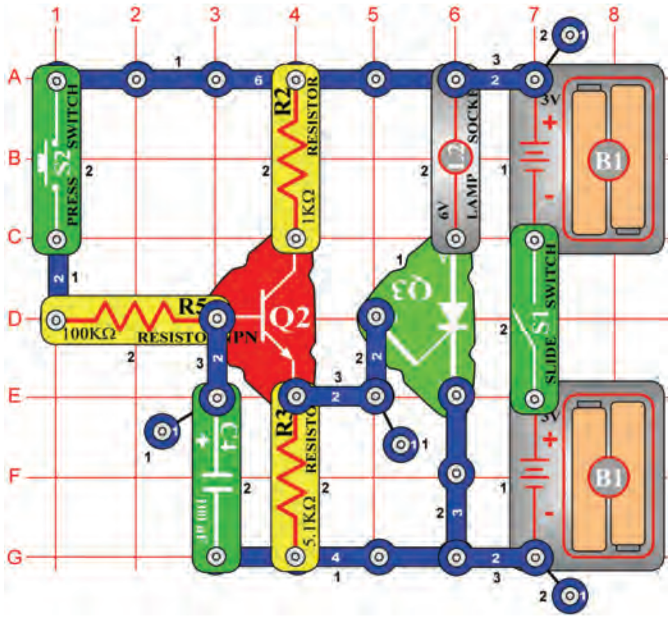
☐ # Project #380 — Light & Alarm IC

OBJECTIVE: To build an alarm circuit.

Use the circuit in project #379. Replace the 10kΩ resistor (R4) with the photoresistor (RP) and remove the jumper wire. When enough light strikes the photoresistor, the Alarm IC (U2) plays. Cover the photoresistor with your hand. Now slowly remove it, when enough light hits the resistor, the IC plays.

Project #381 Delay Light

OBJECTIVE: To construct a time delay circuit.



Turn on the slide switch (S1) and the bulb (L2) does not light. Press switch (S2) and slowly the bulb lights.

When the press switch is pressed, current flows to the base of the transistor (Q2) and charges the 100μF capacitor (C4). When the capacitor charges up to more than 1 volt, the transistor (Q2) turns on and triggers the SCR (Q3). The bulb will stay lit until the slide switch is turned off. The values R5 and C4 determine the time it takes until the transistor turns on. The larger the capacitor value, the more time it takes to turn on.

Project #382 Delay Fan

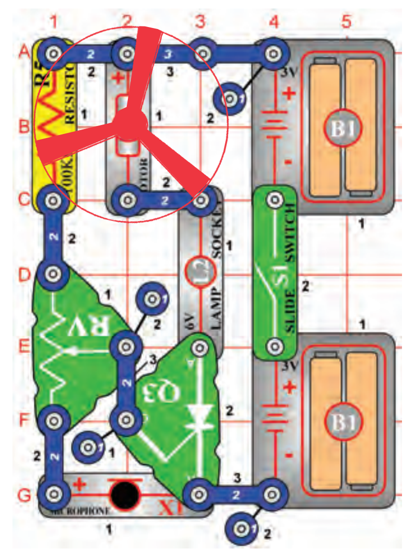
OBJECTIVE: To construct a time delay fan.

Use the circuit in project #381. Replace the lamp (L2) with the motor (M1) and fan, then replace the 3-snap (base grid locations E6-G6) with the lamp (L2). Turn on slide switch (S1) and press down the press switch (S2) to start the motor.

Now replace the 100μF capacitor (C4) with the 470μF capacitor (C5). Turn on slide switch (S1) and press switch (S2). See how long it takes until the motor (M1) spins.

WARNING: Moving parts. Do not touch the fan or motor during operation. Do not lean over the motor.

Project #383 Sound Activated Fan



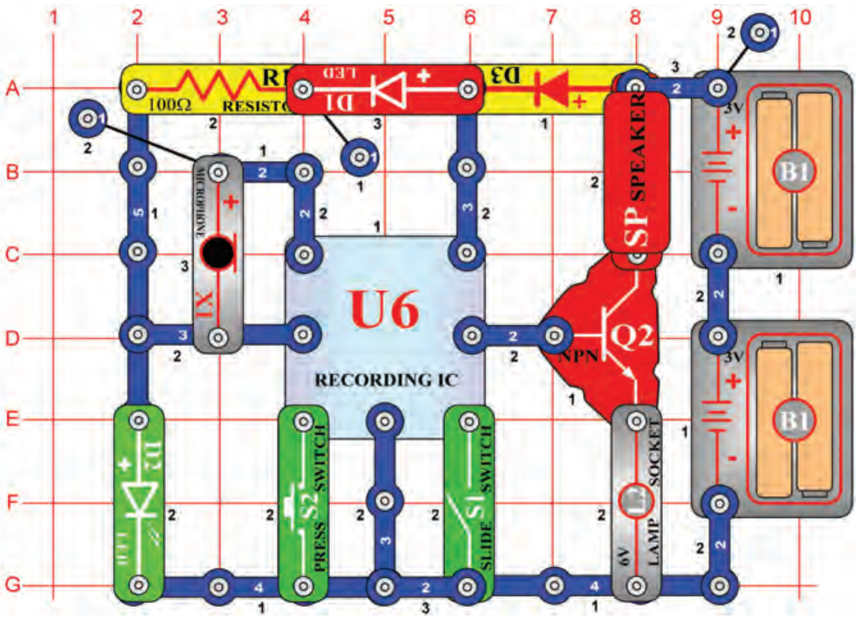
OBJECTIVE: To build a sound activated fan.

Build the circuit as shown. Place the fan on the motor (M1). Set the lever on the adjustable resistor (RV) toward towards the 100kΩ resistor (R5). Clap to start the motor.

WARNING: Moving parts. Do not touch the fan or motor during operation. Do not lean over the motor.

Project #384

Recording LED Indicator

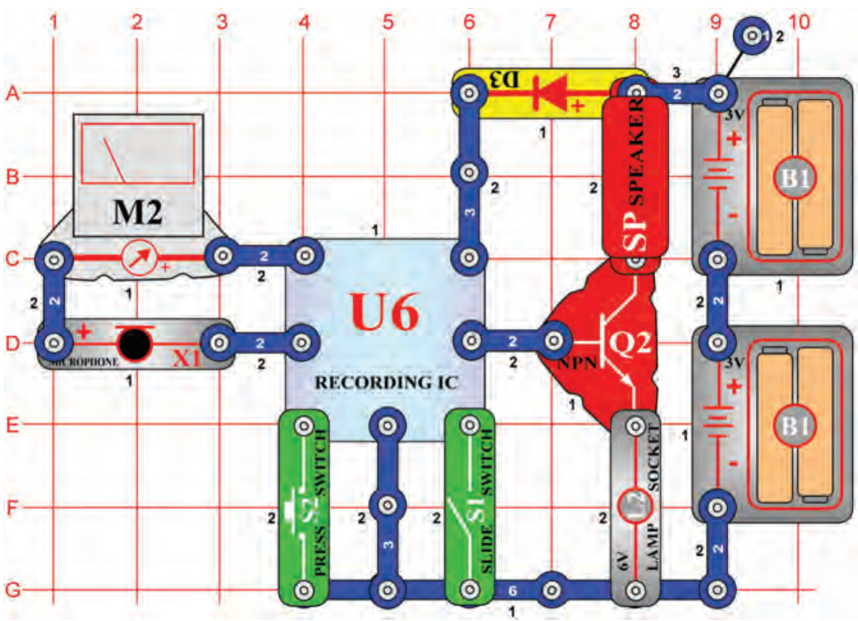


OBJECTIVE: *To build a circuit that lights an LED to indicate the recording mode.*

The circuit uses sound (beep) and light (LED) to indicate that you are recording. Build the circuit; the red (D1) and green (D2) LED's should light. Now turn on the slide switch (S1). You hear one beep and the green LED turns off. Speak into the microphone (X1) to record a message. When you turn off the slide switch, or the circuit beeps twice (indicating the recording is finished), the green LED turns on again. Make sure that the slide switch is turned off. Press the press switch to hear your recording followed by a song. The lamp (L2) is used to limit current and will not light.

Project #385

Playback & Record with Meter



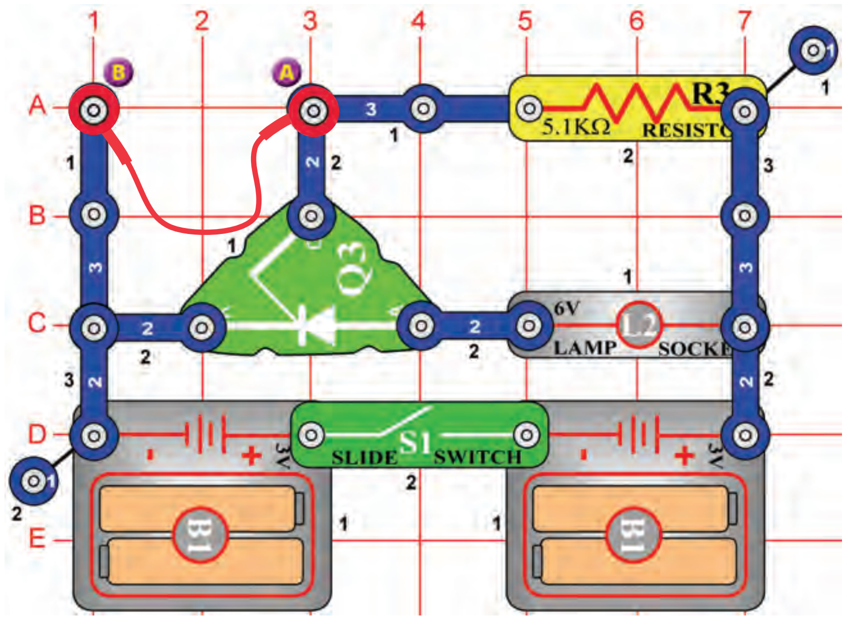
OBJECTIVE: *To add a volt meter to the playback and record circuit.*

When recording, if the input signal into the microphone (X1) is too high, distortion can occur. To monitor the level, a meter (M2) is placed in series with the microphone.

Set the meter to the LOW (or 10mA) scale. Turn on the slide switch (S1) and the meter defects to the right. As you speak into the microphone, the meter indicates the change in current. Turn the switch off and then on to record again, but this time speak louder. You will find that the louder you speak, the more the meter deflects. The lamp (L2) is used to limit current and will not light.

Project #386 — Alarm Light

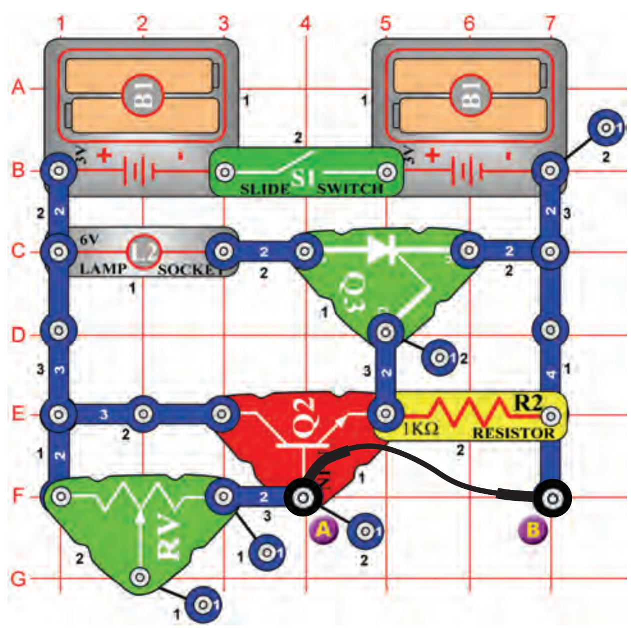
OBJECTIVE: To light a bulb to indicate an open circuit.



This is another example of a alarm that activates when the circuit is broken. Connect the jumper wire across points A & B and then turn on the slide switch (S1). The lamp (L2) will not light until the jumper wire is disconnected. Then the lamp will not turn off. Turn off the switch to turn the lamp off again. This circuit remembers if there was a break in the connection.

Project #387 — Alarm Light (II)

OBJECTIVE: To light a bulb to indicate an open circuit.

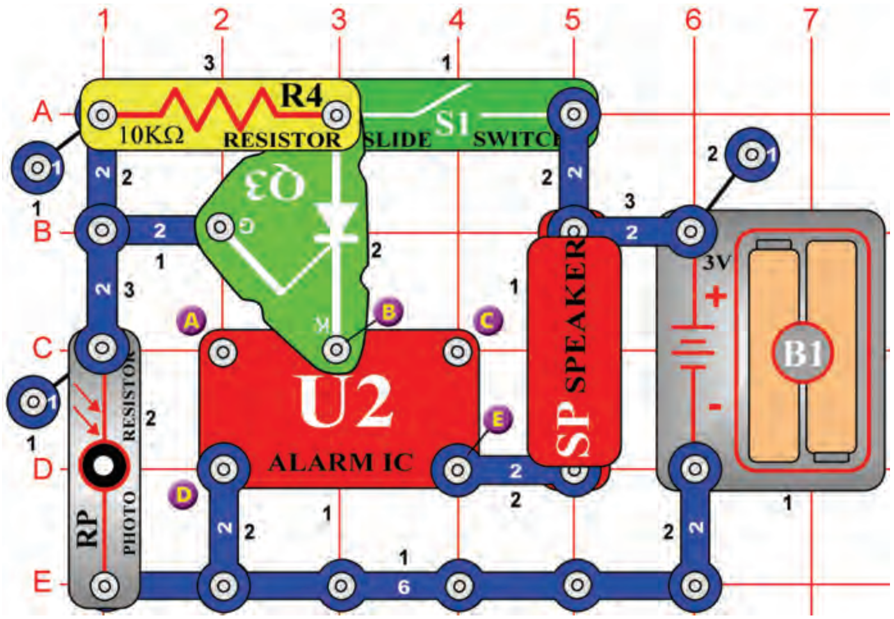


This project is similar to project #386, but uses a transistor (Q2). The lamp (L2) will not light until the jumper wire is disconnected. The jumper wire grounds the base of the transistor, keeping it off. Remove the jumper and the voltage on the base rises; turning the transistor and SCR (Q3) on, and lighting the lamp. Note, the adjustable resistor (RV) is used as a fixed value. Once the SCR is triggered, it will light the lamp even if the jumper wire is replaced. Turn the slide switch (S1) off to turn off the lamp.

Project #388

Night Police Car

OBJECTIVE: To build a night-sensitive police car sound.



As the photoresistor (RP) is exposed to light, its resistance is very low, thereby connecting the gate of the SCR (Q3) to ground. This prevents the SCR from conducting, connecting the alarm IC (U2) to the batteries. The alarm IC remains off until the light is blocked, triggering the SCR. If the light in the room is not bright, the IC may turn on.

Wave your hands over the photoresistor. Block the light with your hand and the speaker (SP) sounds.

Project #389

Night Machine Gun

OBJECTIVE: To build a night-sensitive machine gun sound.

Use the circuit from project #388. Connect the jumper wire to points B & C for a machine gun sound.

Project #390

Night Fire Engine

OBJECTIVE: To build a night-sensitive fire engine sound.

Use the circuit from project #388. Connect the jumper wire to points A & B for a fire engine sound.

Project #391

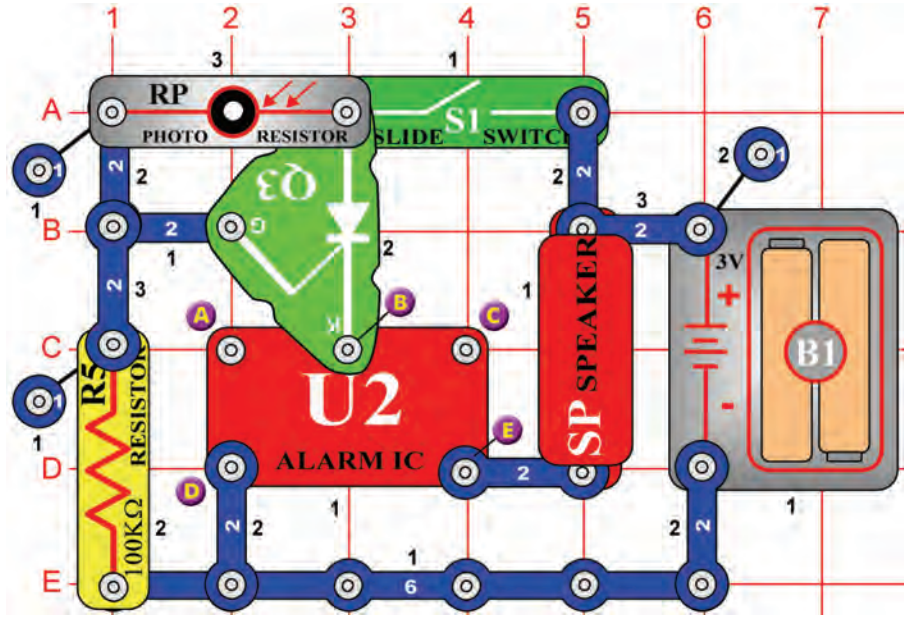
Night Ambulance

OBJECTIVE: To build a night-sensitive ambulance sound.

Use the circuit from project #388. Connect the jumper wire to points A & D for an ambulance sound.

☐ Project #392

Daytime Light Police Car



OBJECTIVE: To build a light-sensitive police car sound.

As long as the photoresistor (RP) is exposed to light, the alarm IC (U2) outputs a signal to the speaker (SP). Block the light with your hand and the sound will stop.

☐ Project #393

Daytime Light Machine Gun

OBJECTIVE: To build a light-sensitive machine gun sound.

Use the circuit from project #392. Connect the jumper wire to points B & C. The sound of a machine gun will be heard when the room is not dark.

☐ Project #394

Daytime Light Fire Engine

OBJECTIVE: To build a light-sensitive fire engine sound.

Use the circuit from project #392. Connect the jumper wire to points A & B for a fire engine sound, when room is not dark.

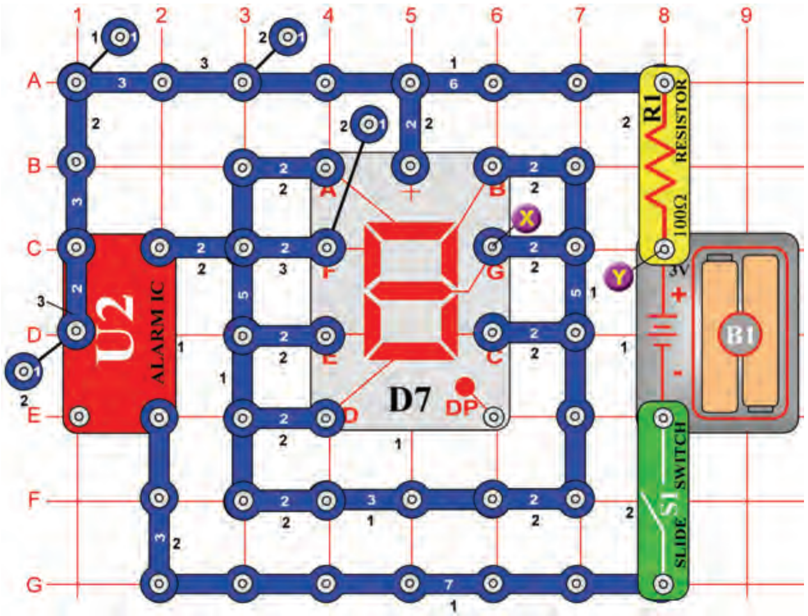
☐ Project #395

Daytime Light Ambulance

OBJECTIVE: To build a light-sensitive ambulance sound.

Use the circuit from project #392. Connect the jumper wire to points A & D for an ambulance sound.

☐ **Project #396** **Flashing 8**



OBJECTIVE: Use the Alarm IC as a switch to flash the number "8".

Turn on the slide switch (S1) and the number 8 starts flashing. The segments are powered by connecting them to the IC's (U2) output.

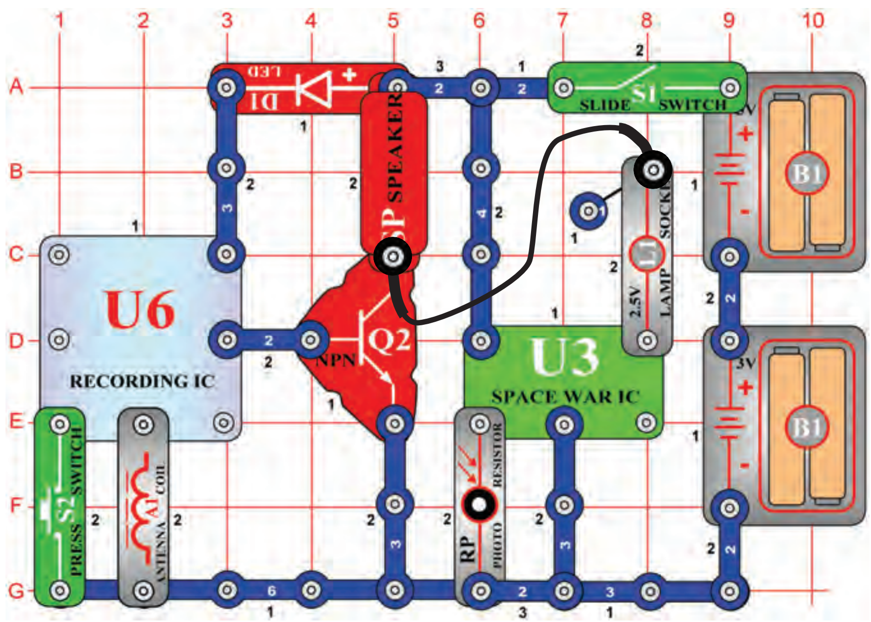
☐ **Project #397**

Flashing 8 with Sound

OBJECTIVE: To build a circuit so you can hear and see the 8 flash.

Use the circuit in project #396. Connect the speaker (SP) across points X & Y to see and hear the IC's (U2) output.

☐ **Project #398** **Musical Space War**



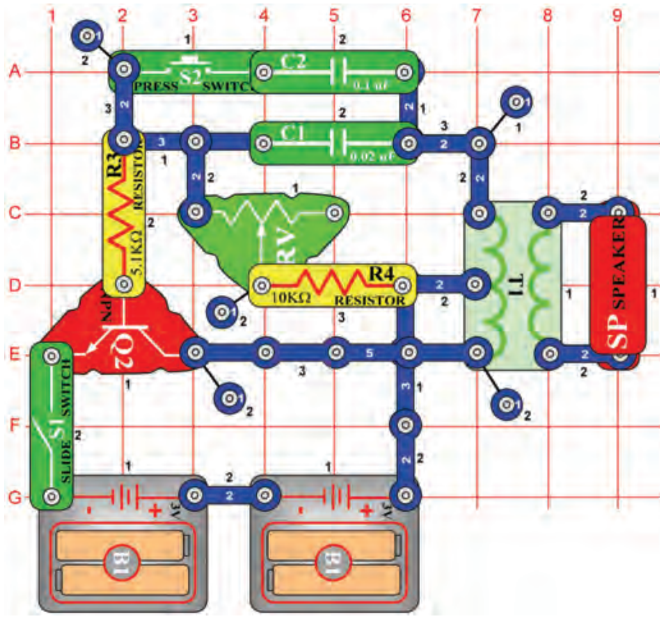
OBJECTIVE: To combine the sound effects of the recorder and space war integrated circuits.

Turn on the slide switch (S1) and you hear space war sounds as the lamp (L1) flashes. If you wave your hand over the photoresistor (RP), the sound changes. If you keep the photoresistor covered, then the sound will stop.

Press the press switch (S2) and you will hear music in addition to any space war sounds that are playing. Press the press switch again to change the music. You will also hear any recording you had made previously with other projects.

Replace the lamp with the 100Ω resistor (R1) to reduce the loudness.

☐ Project #399 Electronic Noisemaker



OBJECTIVE: To make different tones with an oscillator.

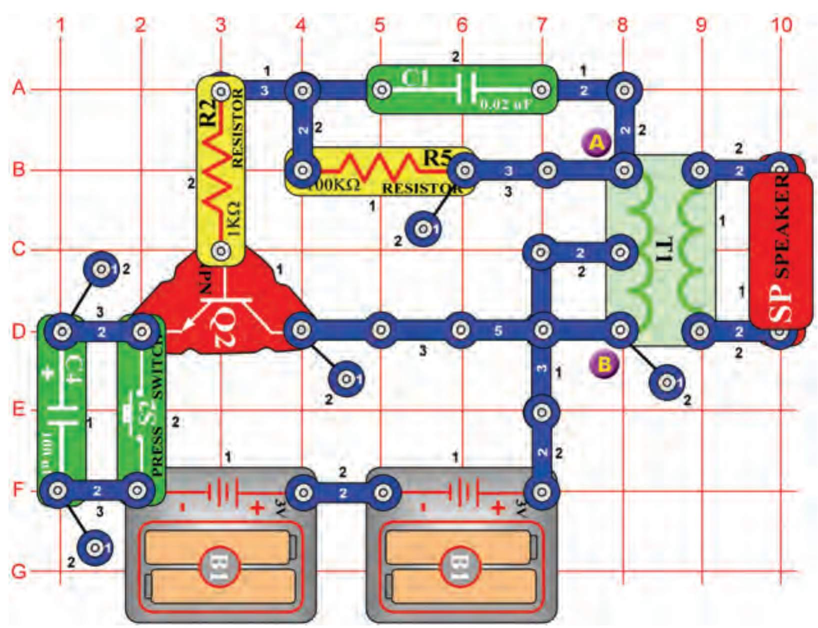
Build the circuit and turn on the slide switch (S1), you hear a high-frequency tone. Press the press switch (S2) and move the adjustable resistor (RV) control around to change to frequency of the tone. Replace the 0.1μF capacitor (C2) with the 10μF capacitor (C3, "+" on the right) to lower the frequency of the tone.

☐ Project #400 Electronic Noisemaker (II)

OBJECTIVE: To show a variation of project #399.

You can also change the frequency by changing the resistance in the oscillator. Replace the 10KΩ resistor (R4) with the 100KΩ resistor (R5), this can be done with either the 0.1μF (C2) or 10μF (C3) capacitors in the circuit.

☐ Project #401 Bee



OBJECTIVE: To make different sounds with an oscillator.

Build the circuit and press the press switch (S2) a few times, you hear cute sounds like a bumble bee. Replace the 0.02μF capacitor (C1) with 0.1μF capacitor (C2) or 10μF capacitor (C3, "+" on the right) to change the sound.

☐ Project #402 Bee (II)

OBJECTIVE: Show a variation of project #401.

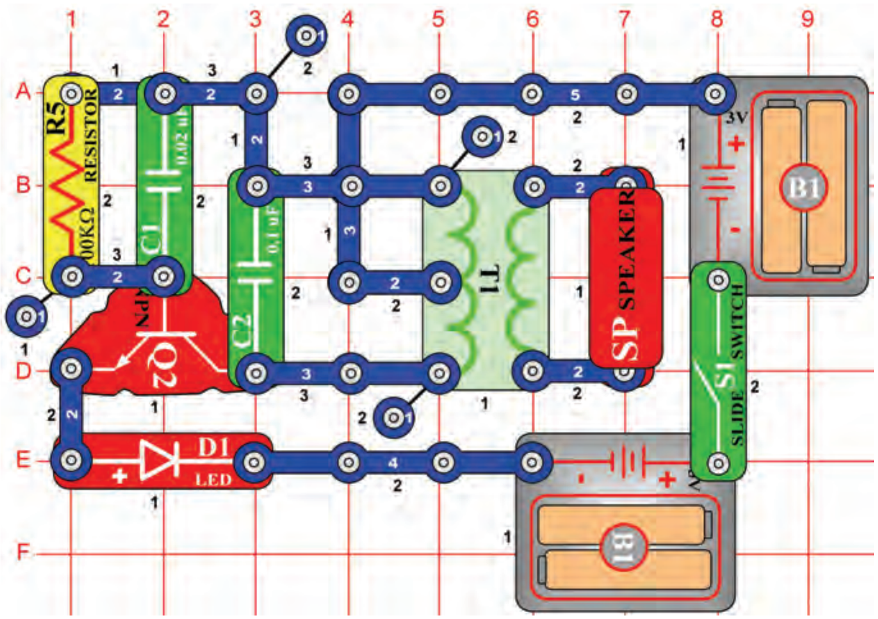
Place the 0.02μF capacitor (C1) back in the circuit. Remove the speaker (S1) from the circuit and place the whistle chip (WC) across the transformer (T1) at points labeled A & B on the circuit layout. Listen to the sounds as you press the press switch (S2). Replace the 0.02μF capacitor (C1) with 0.1μF capacitor (C2) or 10μF capacitor (C3, "+" on the right) to change the sound.

☐ Project #403 Bee (III)

OBJECTIVE: Show a variation of project #401.

Replace the 100μF capacitor (C4) with the 10μF capacitor (C3) or the 470μF capacitor (C5) to change the duration of the sound. Use either the speaker circuit in project #401 or the whistle chip circuit in project #402.

☐ Project #404 Oscillator Sound



OBJECTIVE: Build an oscillator circuit.

Turn on the slide switch (S1) and the LED (D1) lights as the speaker (SP) emits a tone. The circuit oscillates and generates an AC voltage across the speaker through the transformer (T1).

☐ Project #405 Oscillator Sound (II)

OBJECTIVE: Show variations of project #404.

Use the circuit in project #404. In this circuit, you will change the tone by adding more capacitance. Place the whistle chip (WC) on top of capacitor (C1). Turn on the slide switch (S1) and you now hear a lower tone. Adding the more capacitance lowers the oscillating frequency.

☐ Project #406 Oscillator Sound (III)

OBJECTIVE: Show variations of project #404.

Use the circuit in project #404. Place the whistle chip (WC) in parallel with the capacitor (C2) by placing it on the left side of the transformer (T1). Turn on the slide switch (S1) and you now hear a lower tone.

☐ Project #407 Oscillator Sound (IV)

OBJECTIVE: Show variations of project #404.

Use the circuit in project #404. Using a 1-snap, place the 10μF capacitor (C3) on top of the 100kΩ resistor (R5), with the "+" side on point A1. Turn on the slide switch (S1) and you should hear a much lower sound then the previous projects.

☐ Project #408 Oscillator Sound (V)

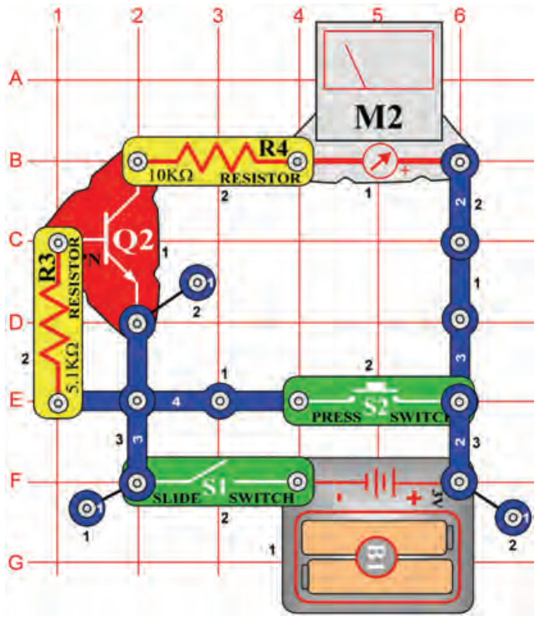
OBJECTIVE: Show variations of project #404.

Use the circuit in project #404. Replace the 100kΩ resistor (R5) with the photoresistor (RP). Wave your hand over the photoresistor. Now, as the resistance changes, so does the oscillator frequency.

☐ Project #409

Transistor Tester

OBJECTIVE: To build a circuit that checks the transistor.

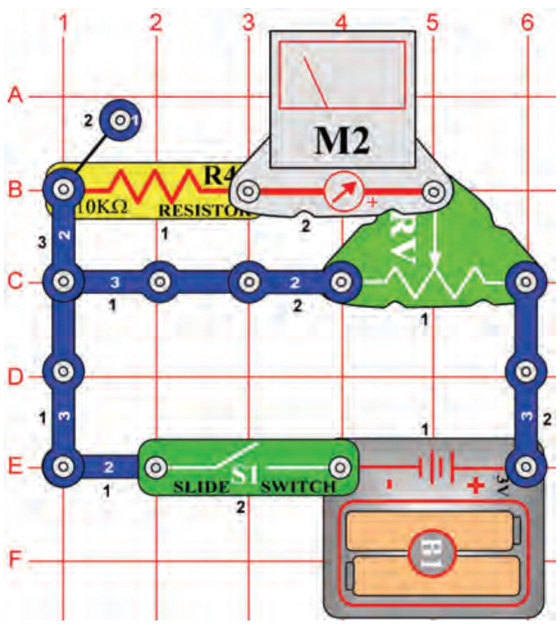


Set the meter (M2) to the LOW (or 10mA) setting. Turn on the switch (S1), the meter does not move. Press the switch (S2), the meter deflects and points to 10. This indicates the transistor (Q2) is GOOD. The meter would only deflect a little or not at all for a BAD transistor.

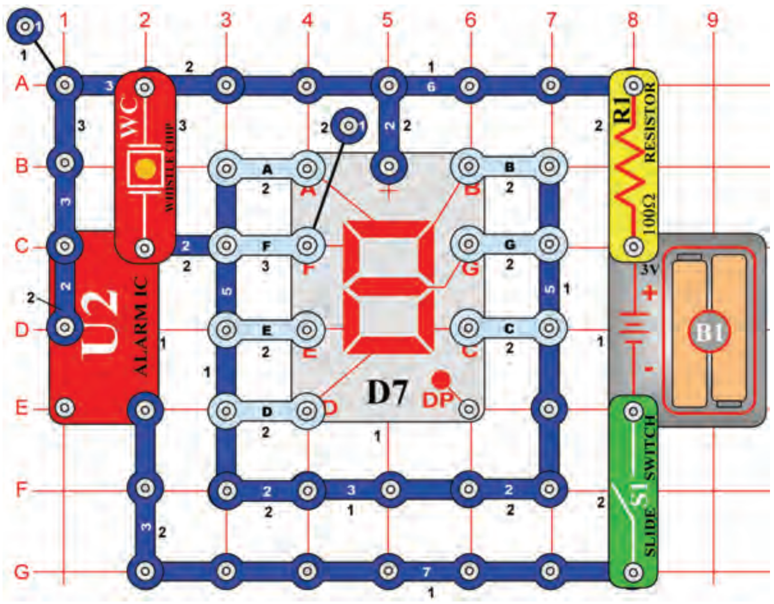
☐ Project #410

Adjustable Voltage Divider

OBJECTIVE: To make an adjustable current path.



Set the meter (M2) to the LOW (or 10mA) setting. This circuit is a simple voltage divider. When the adjustable resistor (RV) is set to the far right, the voltage across the resistors (R4) and (RV) are equal. Adjust resistor (RV) to the left, the meter deflects less, as the voltage decreases.



Project #411

Automatic Display Capital Letter "C"

OBJECTIVE: To construct a flashing display for the capital letter C.

Connect segments A, D, E & F to the circuit. Turn on the switch (S1), the display flashes and the whistle chip (WC) buzzes on and off.

Project #412

Automatic Display Capital Letter "E"

OBJECTIVE: To construct a flashing display for the capital letter E.

Use the circuit from project #411. Connect A, D, E, F, & G to the circuit. Turn on the switch (S1), the display flashes and the whistle chip (WC) buzzes on and off.

Project #413

Automatic Display Capital Letter "F"

OBJECTIVE: To construct a flashing display for the capital letter F.

Use the circuit from project #411. Connect A, E, F, & G to the circuit. Turn on the switch (S1), the display flashes and the whistle chip (WC) buzzes on and off.

Project #414

Automatic Display Capital Letter "H"

OBJECTIVE: To construct a flashing display for the capital letter H.

Use the circuit from project #411. Connect B, C, E , F, & G to the circuit. Turn on the switch (S1), the display flashes and the whistle chip (WC) buzzes on and off.

Project #415

Automatic Display Capital Letter "P"

OBJECTIVE: To construct a flashing display for the capital letter P.

Use the circuit from project #411. Connect A, B, E, F, & G to the circuit. Turn on the switch (S1), the display flashes and the whistle chip (WC) buzzes on and off.

Project #416

Automatic Display Capital Letter "S"

OBJECTIVE: To construct a flashing display for the capital letter S.

Use the circuit from project #411. Connect A, F, G, C, & D to the circuit. Turn on the switch (S1), the display flashes and the whistle chip (WC) buzzes on and off.

Project #417

Automatic Display Capital Letter "U"

OBJECTIVE: To construct a flashing display for the capital letter U.

Use the circuit from project #411. Connect B, C, D, E, & F to the circuit. Turn on the switch (S1), the display flashes and the whistle chip (WC) buzzes on and off.

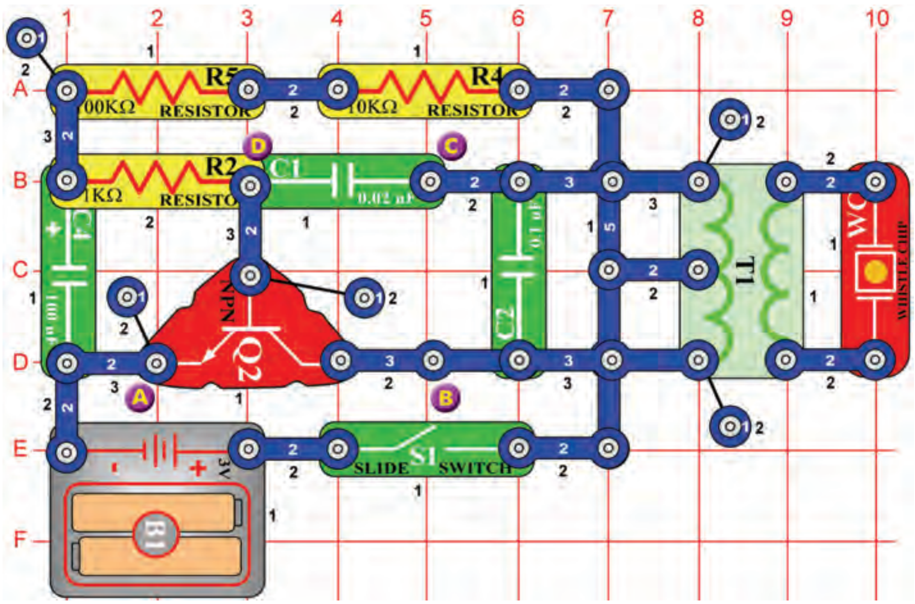
Project #418

Automatic Display Capital Letter "L"

OBJECTIVE: To construct a flashing display for the capital letter L.

Use the circuit from project #411. Connect D, E, & F to the circuit. Turn on the switch (S1), the display flashes and the whistle chip (WC) buzzes on and off.

To learn more about how circuits work, visit www.snapcircuits.net or page 62 to find out about our Student Guides.



Project #419
Whistle Chip Sounds

OBJECTIVE: To make sounds from the whistle chip.

Turn on the switch (S1). As the circuit oscillates, the plate in the whistle chip vibrates and generates sound.

Project #420
Whistle Chip Sounds (II)

OBJECTIVE: Show variations of project #419.

Connect the whistle chip (WC) across points B & C.

Project #421
Whistle Chip Sounds (III)

OBJECTIVE: Show variations of project #419.

Use the circuit in project #419. Connect the whistle chip (WC) across points C & D. You should hear a faster sound.

Project #422
Whistle Chip Sounds (IV)

OBJECTIVE: Show variations of project #419.

Use the circuit in project #419, but replace the 100µF capacitor (C4) with the 10µF capacitor (C3).

Project #423
Whistle Chip Sounds (V)

OBJECTIVE: Show variations of project #419.

Use the circuit in project #419, but replace the 100µF capacitor (C4) with the 470µF capacitor (C5).

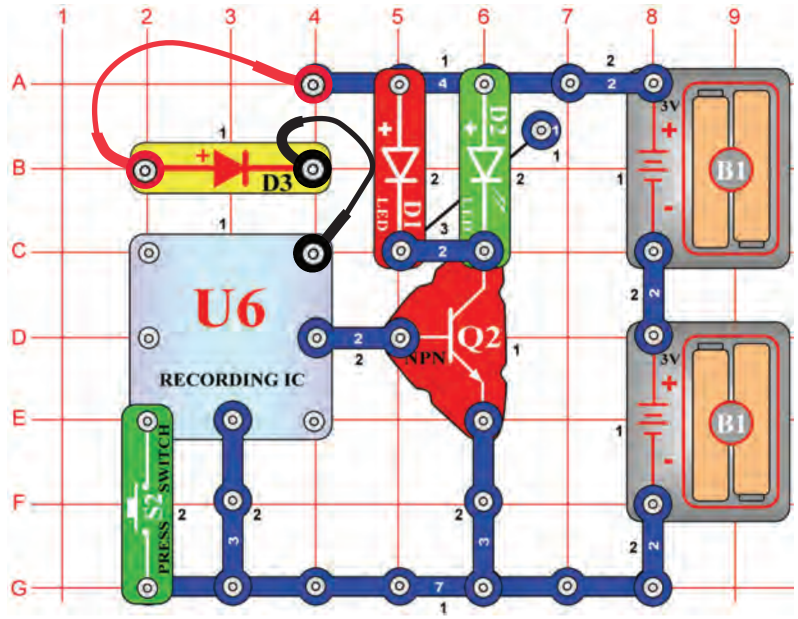
Project #424
Whistle Chip Sounds (VI)

OBJECTIVE: Show variations of project #419.

Use the circuit in project #419, but replace the 100µF capacitor (C4) with the 10µF capacitor (C3) and connect the whistle chip across points B & C. You can also connect the whistle chip across points C & D.

Project #425 LED Music

OBJECTIVE: To light the LED's using the recording IC.



The recording IC (U6) lights the LED's (D1 & D2) instead of driving the speaker (SP). Press the press switch (S2) once. The LED's light and then turn off after a while. Press the press switch again and see how long the second song plays. When the second song stops, press the press switch (S2) again to play the third song.

Project #426 Light-controlled LED Time Delay

OBJECTIVE: Show variations of project #425.

Use the circuit in project #425. Replace the press switch (S2) with the photoresistor (RP). Turn the LED's on and off by waving your hand over the photoresistor.

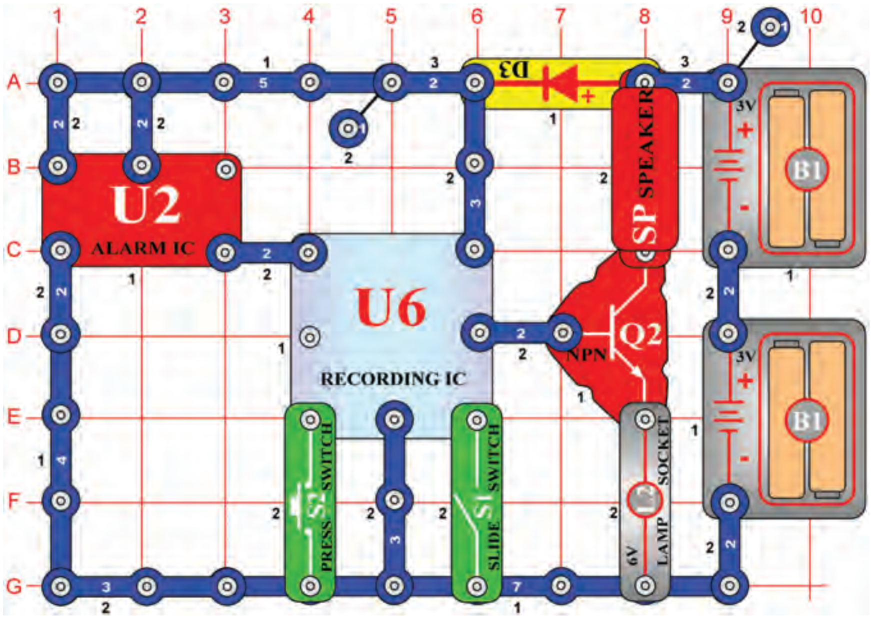
Project #427 Touch-controlled LED Time Delay

OBJECTIVE: Show variations of project #425.

Use the circuit in project #425. Replace the press switch (S2) with the PNP transistor (Q1, arrow on U6 and a 1-snap on point F1). Turn the LED's on and off by touching grid points F1 & G2 at the same time. You may need to wet your fingers.

Project #428 Alarm Recorder

OBJECTIVE: To record the sound from the alarm IC.



The circuit records the sound from the alarm IC (U2) into the recording IC (U6). Turn on the switch (S1). The first beep indicates that the IC has begun recording. When you hear two beeps, the recording has stopped. Turn off the slide switch (S1) and press the switch (S2). You will hear the recording of the alarm IC before each song is played. The lamp (L2) is used to limit current and will not light.

Project #429 Alarm Recorder (II)

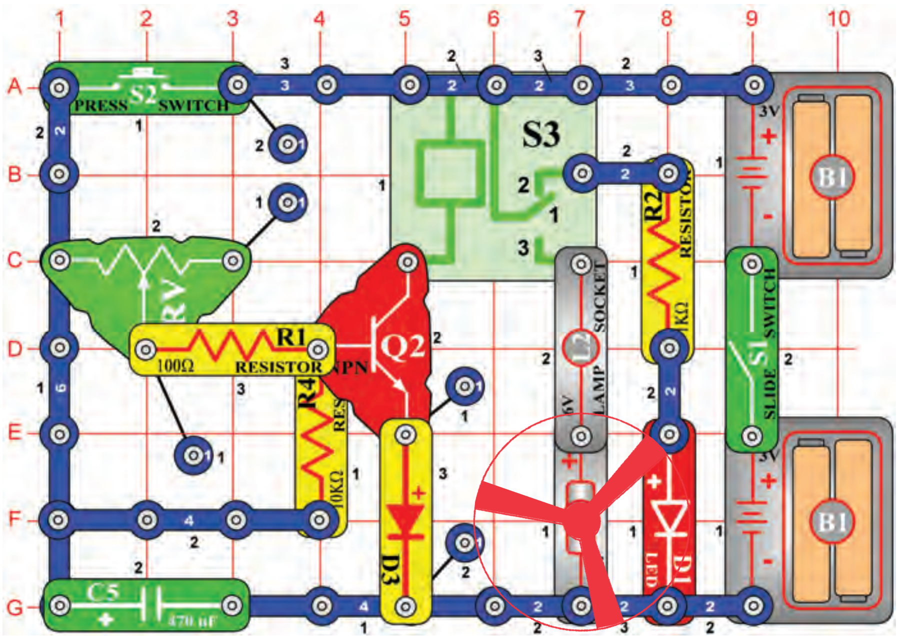
OBJECTIVE: Record the sound from the alarm IC.

Use the circuit in project #428. Remove the 2-snap from A1 to B1. Turn on the switch (S1). The first beep indicates that the IC (U6) has begun recording. When you hear two beeps, turn off the switch (S1), press the switch (S2), and the new recording plays.

Project #430 Machine Gun Recorder

OBJECTIVE: To record the sound of a machine gun.

Use the circuit in project #428. Move the 2-snap from A1 - B1 to 3A - 3B. Turn on the switch (S1). The first beep indicates that the IC (U6) has begun recording. When you hear two beeps, turn off the switch (S1), press the switch (S2), and the machine gun sound plays.



> **WARNING:** Moving parts. Do not touch the fan or motor during operation. Do not lean over the motor.

Project #431
Time Delay 1-7 Seconds

OBJECTIVE: To build a time delay circuit.

The length of time the motor (M1) runs depends on the position of the adjustable resistor (RV). When the press switch (S2) is pressed, the 470µF capacitor (C5) charges. As the press switch is released, C5 discharges through the resistors R4 and RV, turning the transistor (Q2) on. Transistor Q2 connects the relay (S3) to the batteries, the contacts switch, and the motor (M1) spins. As the voltage decreases, Q2 will turn off and the motor will stop spinning.

Setting RV to the right (large resistance) sets a long discharge time. To the left, a short discharge time.

Turn on the switch (S1), the red LED (D1) lights. Now press and release the switch (S2), the bulb lights and the motor spins.

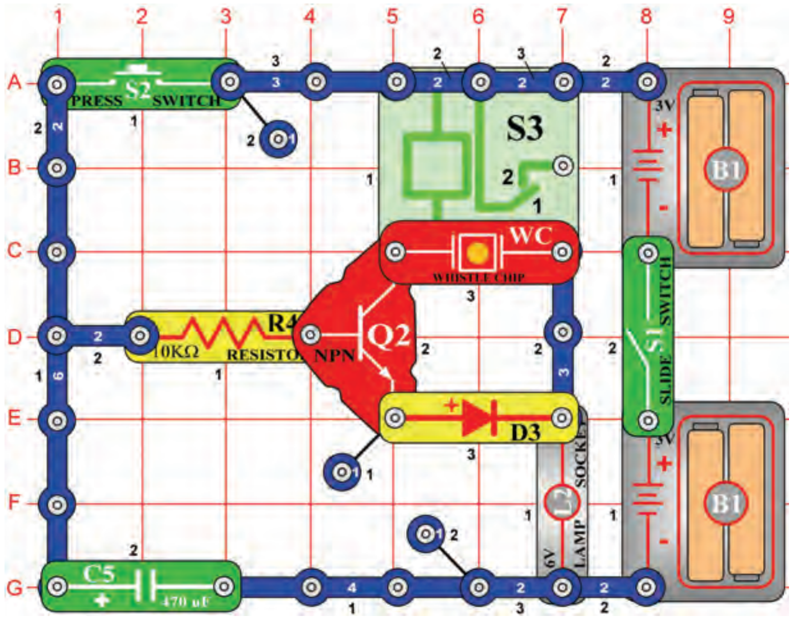
Project #432
Time Delay

OBJECTIVE: To see how the capacitor value affects the time.

Use the circuit in project #431. Replace the 470µF capacitor (C5) with the 100µF capacitor (C4). Set the adjustable resistor (RV) to the far right, turn on the switch (S1), then press and release the switch (S2). The motor (M1) spins and bulb (L2) lights for about 3 seconds. Adjust the adjustable resistor to the left for a much shorter time.

Project #433

Manual 7 Second Timer (II)

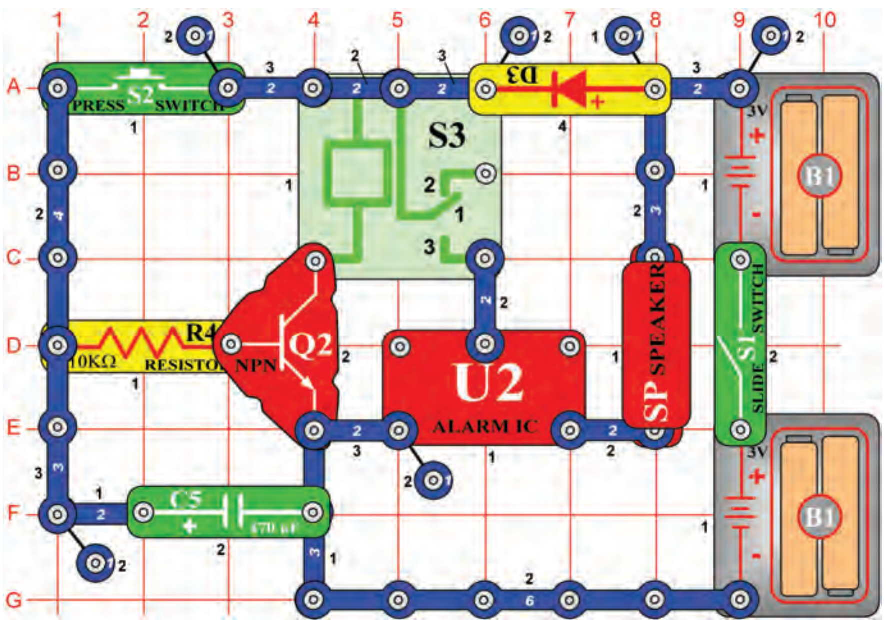


OBJECTIVE: To build a manual timer using a relay and whistle chip.

This circuit is similar to project #431 except now the whistle chip (WC) will also make sound.

Project #434

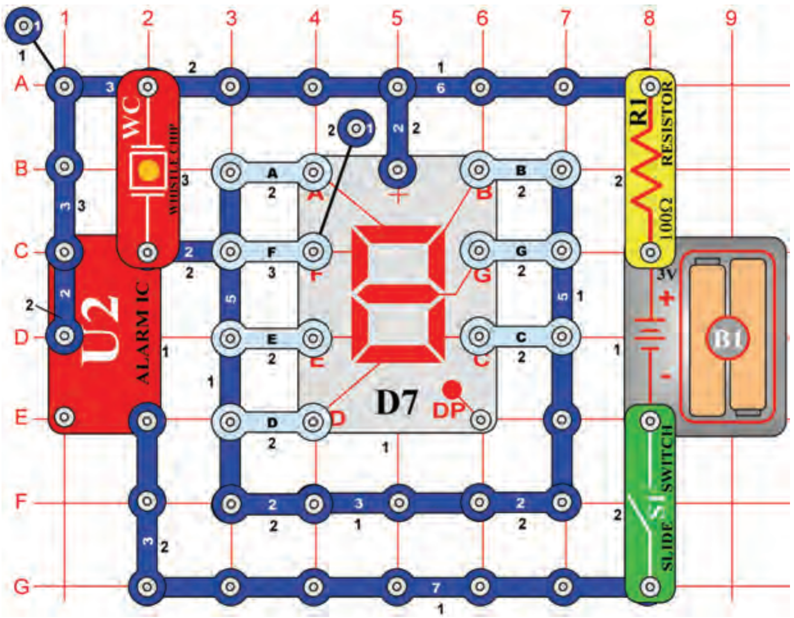
15 Second Alarm



OBJECTIVE: To build a circuit that sounds the speaker for 15 seconds.

As in project #431, the transistor (Q2) acts as a switch, connecting the relay (S3) and the alarm IC (U2) to the batteries. As long as there is a voltage on the transistor's base, the alarm IC sounds.

Turn on the slide switch (S1) and then press the switch (S2). The transistor turns on, the capacitor (C5) charges up, and the alarm sounds. Release the press switch (S2). As the capacitor discharges, it keeps the transistor on. The transistor will turn off when the capacitor is almost discharged, about 15 seconds. The relay contacts will switch and the alarm will turn off.



☐ Project #435

Flashing “1 & 2”

OBJECTIVE: Use the Alarm IC as a switch to flash the numbers “1 & 2”.

Connect segments B & C to the circuit. Turn on the slide switch (S1) and the number “1” should be flashing. Now, connect A, B, G, E, & D to flash the number “2”.

☐ Project #436

Flashing “3 & 4”

OBJECTIVE: Use the Alarm IC as a switch to flash the numbers “3 & 4”.

Use the circuit in project #435. Connect A, B, G, C, & D to the circuit. Turn on the slide switch (S1) and the number “3” should be flashing. Now, connect C, B, G & F to flash the number “4”.

☐ Project #437

Flashing “5 & 6”

OBJECTIVE: Use the Alarm IC as a switch to flash the numbers “5 & 6”.

Use the circuit in project #435. Connect A, F, G, C & D to the circuit. Turn on the slide switch (S1) and the number “5” should be flashing. Now, connect A, C, D, E, F & G to flash the number “6”.

☐ Project #438

Flashing “7 & 8”

OBJECTIVE: Use the Alarm IC as a switch to flash the numbers “7 & 8”.

Use the circuit in project #435. Connect A, B, & C to the circuit. Turn on the slide switch (S1) and the number “7” should be flashing. Now, connect A, B, C, D, E, F & G to flash the number “8”.

☐ Project #439

Flashing “9 & 0”

OBJECTIVE: Use the Alarm IC as a switch to flash the numbers “9 & 0”.

Use the circuit in project #435. Connect A, B, C, D, F, & G to the circuit. Turn on the switch (S1) and the number “9” should be flashing. Now, connect A, B, C, D, E, & F to flash the number “0”.

☐ Project #440

Flashing “b & c”

OBJECTIVE: Use the Alarm IC as a switch to flash the letters “b & c”.

Use the circuit in project #435. Connect C, D, E, F & G to the circuit. Turn on the slide switch (S1) and the letter “b” should be flashing. Now, connect A, F & G to flash the letter “c”.

☐ Project #441

Flashing “d & e”

OBJECTIVE: Use the Alarm IC as a switch to flash the letters “d & e”.

Use the circuit in project #435. Connect B, C, D, E, & G to the circuit. Turn on the slide switch (S1) and the letter “d” should be flashing. Now, connect A, B, D, E, F & G to flash the letter “e”.

☐ Project #442

Flashing “h & o”

OBJECTIVE: Use the Alarm IC as a switch to flash the letters “h & o”.

Use the circuit in project #435. Connect C, E, F, & G to the circuit. Turn on the slide switch (S1) and the letter “h” should be flashing. Now, connect C, D, E, & G to flash the letter “o”.

☐ Project #443

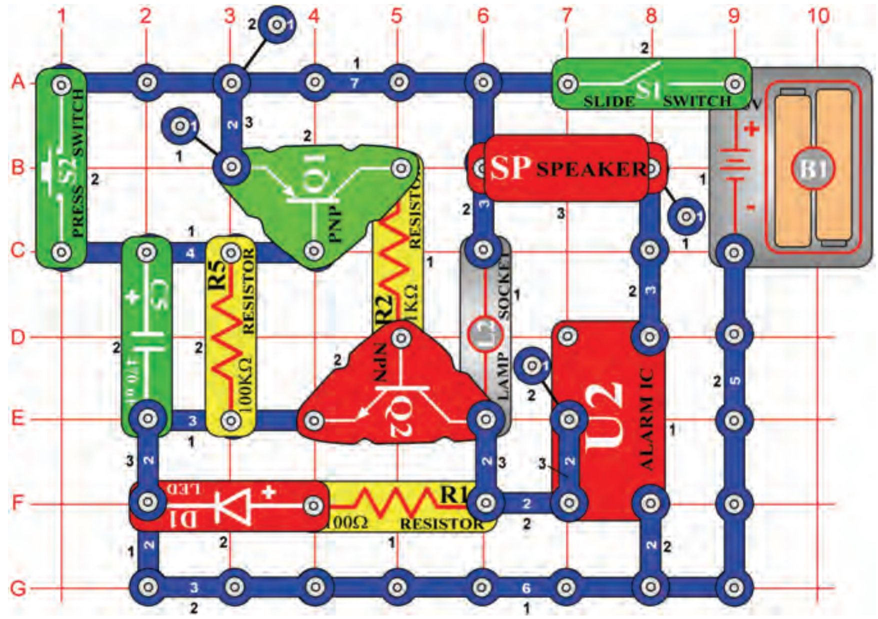
Flashing “A & J”

OBJECTIVE: Use the Alarm IC as a switch to flash the letters “A & J”.

Use the circuit in project #435. Connect A, B, C, E, F, & G to the circuit. Turn on the slide switch (S1) and the capital letter “A” should be flashing. Now, connect B, C, & D to flash the capital letter “J”.

☐ Project #444 Alarm Timer

OBJECTIVE: To connect the alarm IC to a timer circuit.

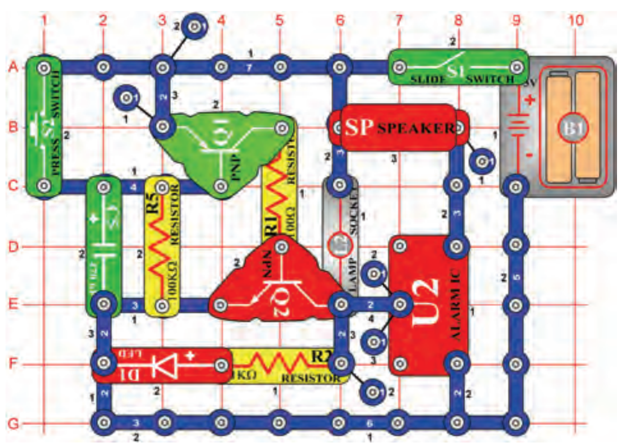


Turn on the slide switch (S1) and the alarm may sound and slowly drift away as the lamp (L2) brightens. Press the press switch (S2) and the alarm sounds at full volume as the LED (D1) lights. Capacitor C5 is also charged. Release the press switch; the alarm IC (U2) still sounds because the voltage from the discharging C5 keeps Q1 and Q2 off. As the capacitor's voltage drops, the LED will turn off and the sound will slowly stop.

Replace resistor R5 and capacitor C5 with different values and see how it affects the circuit.

☐ Project #445 Alarm Timer (II)

OBJECTIVE: To change the time by switching the resistor and capacitor.

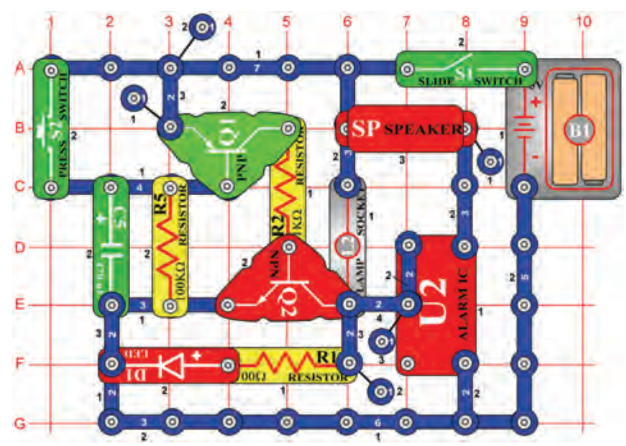


Build this circuit using the following combinations for R5 and C5:

R5 & C3, R4 & C4, and R4 & C5.

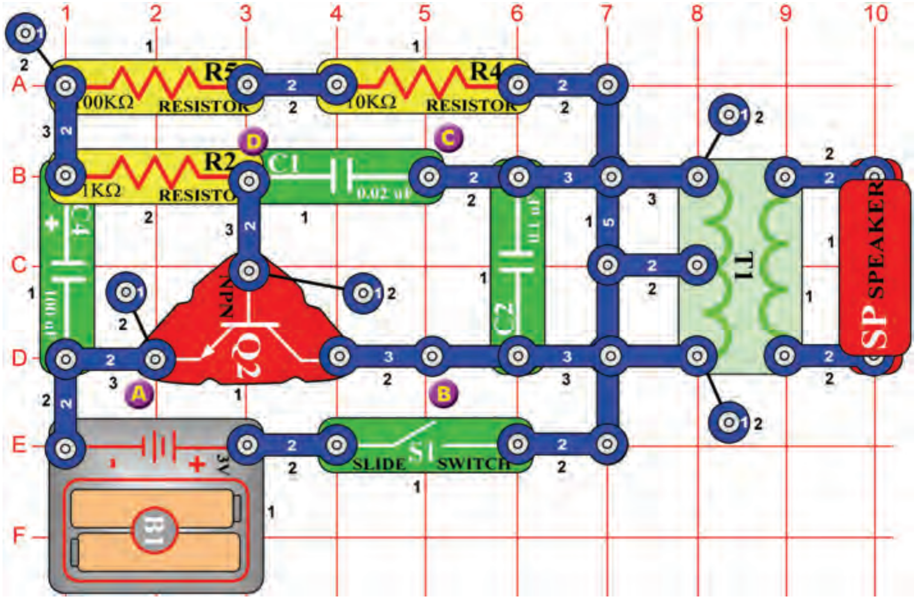
☐ Project #446 Alarm Timer (III)

OBJECTIVE: To modify project #285 for a different sound.



Replace the 1-snap wire from the middle snap on U2 with a 2-snap and connect it to grid location D7 & E7. The circuit now produces a different sound. Change R5 and C5 with the following combinations for R5 and C5:

R5 & C3, R4 & C4, and R4 & C5.



Project #447

Bird Sounds

OBJECTIVE: To create bird sounds.

Turn on the switch (S1). The circuit makes a bird sound.

Project #448

Bird Sounds (II)

OBJECTIVE: To create bird sounds.

Use the circuit in project #447. Replace the 100µF (C4) capacitor with the 10µF capacitor (C3), the tone should sound like a buzzer. Now use the 470µF capacitor (C5) and hear how the tone gets longer between chirps.

Project #449

Bird Sounds (III)

OBJECTIVE: To create bird sounds.

Use the circuit in project #447. Using the jumper wires, connect the whistle chip (WC) across points A & B and the sound changes.

Project #450

Bird Sounds (IV)

OBJECTIVE: To create bird sounds.

Use the circuit in project #447. Connect the whistle chip (WC) across points B & C.

Project #451

Bird Sounds (V)

OBJECTIVE: To create bird sounds.

Using the jumper wires, connect the whistle chip (WC) across points C & D.

Project #452

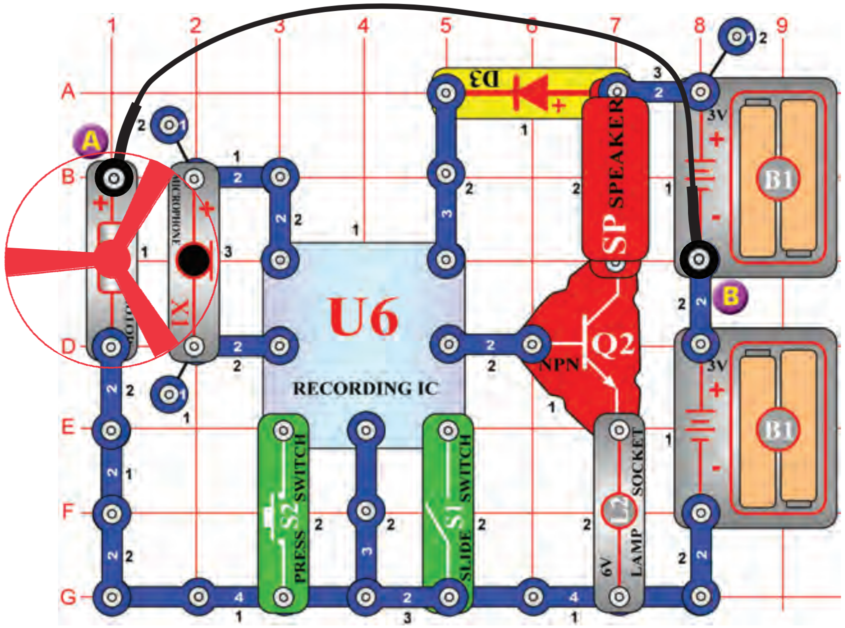
Touch-Control Bird Sound

OBJECTIVE: Show variations of project #447.

Use the circuit in project #447. Replace the 100kΩ resistor (R5) with the photoresistor (RP). Wave your hand over the resistor and the sound changes. With the photoresistor installed, redo projects #448 - 451.

Project #453

Motor Sound Recording



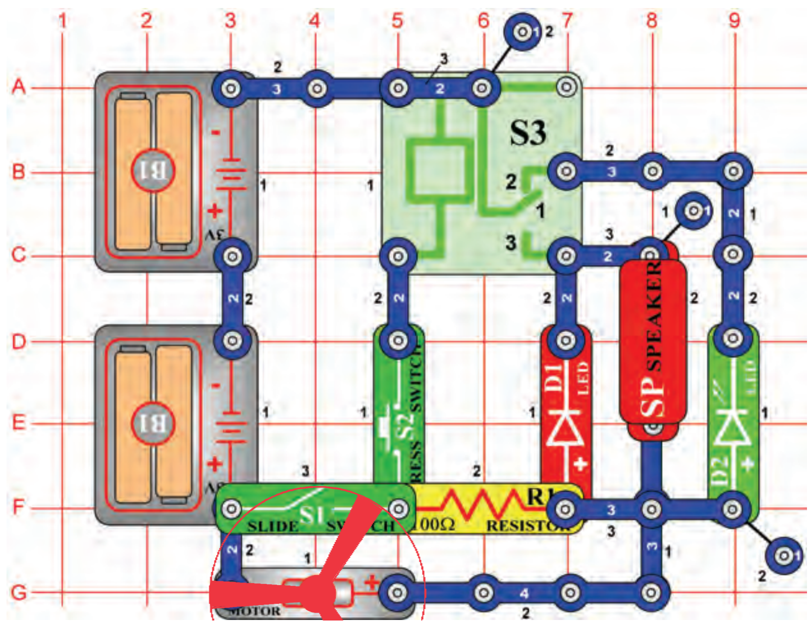
OBJECTIVE: Build a circuit that records the sound of the motor spinning.

Placing the motor (M1) (with the fan attached) next to the microphone (X1) enables you to record the sound as it spins. Turn off and then turn on the switch (S1). After the two beeps, turn off the slide switch (S1) again. Remove the jumper wire connected across points A & B and press the press switch (S2) to hear the recording. The lamp (L2) is used to limit the current and will not light.

WARNING: Moving parts. Do not touch the fan or motor during operation. Do not lean over the motor.

Project #454

Motor Sound Indicator

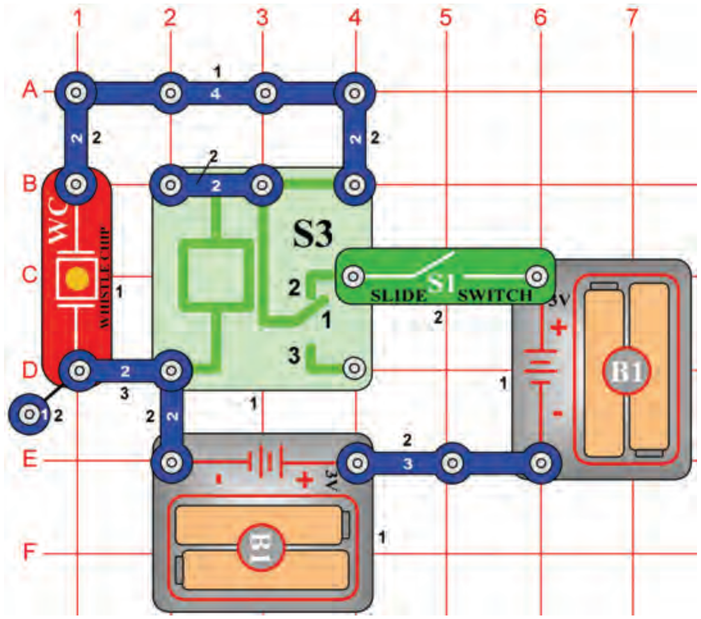


OBJECTIVE: To build a circuit that generates sound as a motor is spinning.

Turn off the switch (S1). There is no power; the LED's and motor are off. Now turn on the switch (S1). Only the green LED (D2) lights, indicating power to the circuit. Press the switch (S2). The motor spins, the red LED (D1) lights, and you hear the motor sound from the speaker (SP).

WARNING: Moving parts. Do not touch the fan or motor during operation. Do not lean over the motor.

Project #455 Relay & Buzzer



OBJECTIVE: Use the whistle chip and relay to make sound.

Turn on the slide switch (S1) and the relay (S3) opens and closes continuously. This creates an AC voltage across the whistle chip (WC), causing it to vibrate and sound.

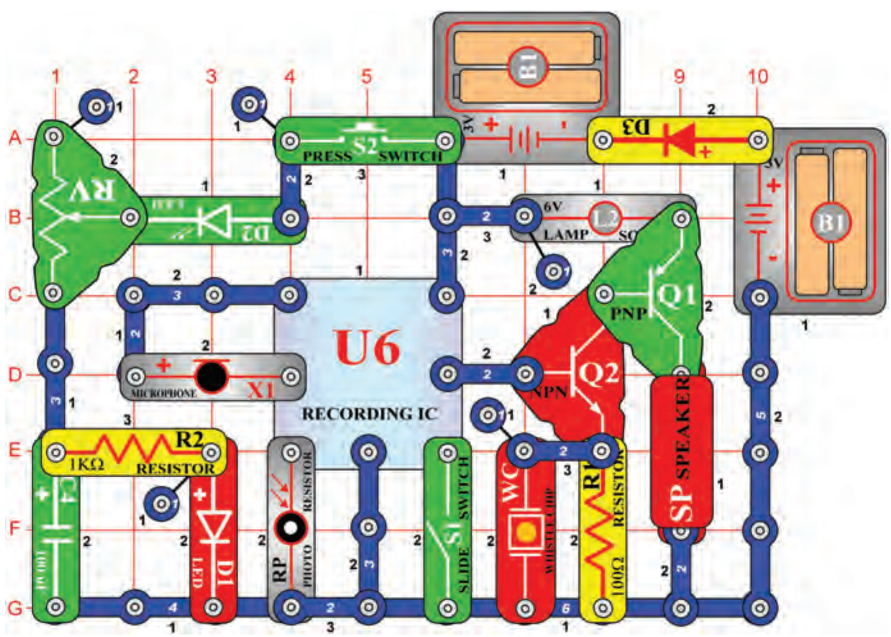
Project #456 Relay & Speaker

OBJECTIVE: Use the speaker and relay to make sound.

Use the circuit from project #455. Replace the whistle chip (WC) with the speaker (SP). Turn on the slide switch (S1) and now you generate a louder sound using the speaker.

Next, replace the whistle chip (WC) with the 6V lamp (L2). Turn on the slide switch (S1) and the lamp lights.

Project #457 Electronic Playground

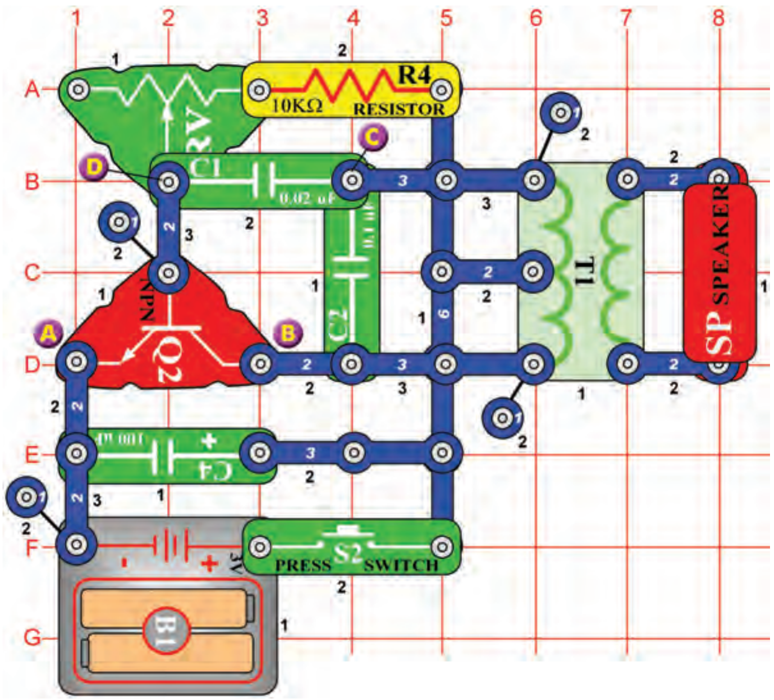


OBJECTIVE: To see how much fun electronics can be.

Uncover the photoresistor (RP) to play a recorded message followed by music, cover it to stop the music.

Turn on the slide switch (S1), you hear a beep signaling that you may begin recording. Talk into the microphone (X1) up to 5 seconds, and then turn off the slide switch (it also beeps after the 5 seconds expires).

Set the lever on the adjustable resistor (RV) down (towards the microphone). Push and release the press switch (S2); the green LED (D2) flashes once while the red LED (D1) stays on longer. The LEDs will be brighter if your batteries are new.



Project #458

Electronic Cat

***OBJECTIVE:** To create the sound of a cat.*

Set the adjustable resistor (RV) to the far left. Press and release the switch (S2). You should hear the sound of a cat from the speaker (SP). Now adjust the resistor and hear the different sounds.

Project #459

Electronic Cat (II)

***OBJECTIVE:** Show variations of project #458.*

Use the circuit in project #458. Connect the whistle chip (WC) across points A & B. Press and release the the switch (S2). You hear sound from the whistle chip and speaker (SP). Adjust the resistor (RV) and hear the different sounds.

Project #460

Electronic Cat (III)

***OBJECTIVE:** Show variations of project #458.*

Use the circuit in project #458. Using the jumper wires, connect the whistle chip (WC) across points B & C. Press and release the switch (S2). Adjust the resistor (RV) and hear the different sounds.

Project #461

Electronic Cat (IV)

***OBJECTIVE:** Show variations of project #458.*

Use the circuit in project #458. Connect the whistle chip (WC) across points C & D. Press and release the switch (S2). Adjust the resistor (RV) and hear the different sounds.

Project #462

Buzzer Cat

***OBJECTIVE:** Show variations of project #458.*

Use the circuit in project #458. Remove the speaker (SP) and connect the whistle chip (WC) across points A & B. Press and release the press switch (S2) to hear the sounds.

Project #463

Buzzer Cat (II)

***OBJECTIVE:** Show variations of project #458.*

Use the circuit in project #458. Remove the speaker (SP) and, using the jumper wires, connect the whistle chip (WC) across points B & C. Press and release the switch (S2). Adjust the resistor (RV) and hear the different sounds.

Project #464

Buzzer Cat (III)

***OBJECTIVE:** Show variations of project #458.*

Use the circuit in project #458. Remove the speaker (SP) and connect the whistle chip (WC) across points C & D. Press and release the switch (S2). Adjust the resistor (RV) and hear the different sounds.

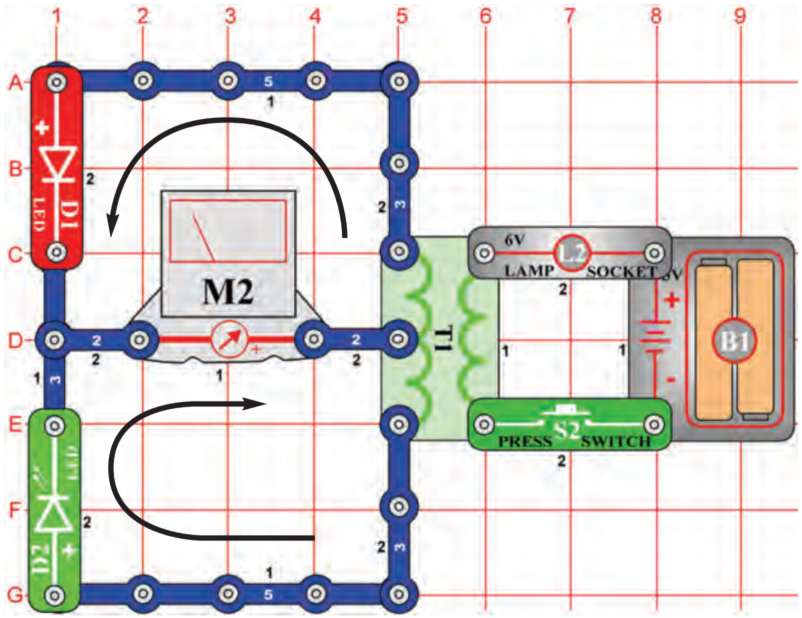
Project #465

Lazy Cat

***OBJECTIVE:** Show variations of project #458.*

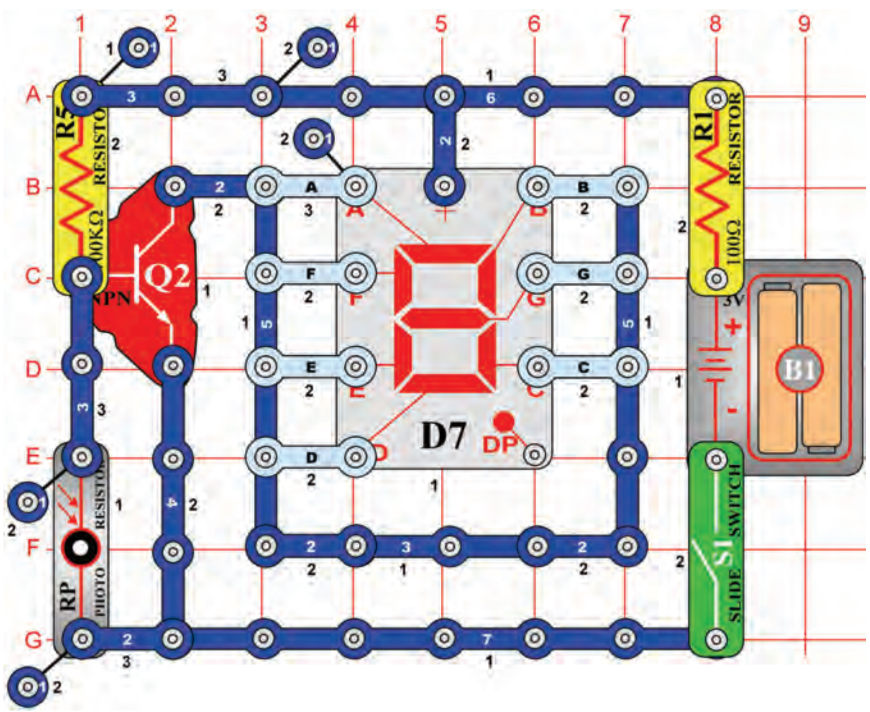
Use the circuit in project #458. Replace the 100μF capacitor (C4) with 470μF (C5). Repeat projects #459-464 and hear 7 different sounds.

☐ # Project #466 Meter Deflection (II)



OBJECTIVE: To build change the direction in which current flows.

Compare this circuit to project #358, which has the LED (D1 & D2) positions reversed. This changes the direction that current can flow. Set the meter (M2) to the LOW (or 10mA) scale. Press the press switch (S2) and now the meter deflects to the left.



☐ # Project #467 Automatic Display #1

OBJECTIVE: Construct a light-controlled display.

Connect segments B & C to the circuit. Turn on the switch (S1), the display should be off. Place your hand over the photoresistor (RP), now the number 1 lights.

☐ # Project #468 Automatic Display #2

OBJECTIVE: Light the number 2 using a light-controlled display.

Use the circuit from project #467. Connect A, B, G, E, & D to the circuit. Turn on the switch (S1), the display should be off. Place your hand over the photoresistor (RP), now the number 2 lights.

Project #469

Automatic Display #3

OBJECTIVE: Light the number 3 using a light-controlled display.

Use the circuit from project #467. Connect A, B, G, C, & D to the circuit. Turn on the switch (S1), the display should be off. Place your hand over the photoresistor (RP), now the number 3 lights.

Project #470

Automatic Display #4

OBJECTIVE: Light the number 4 using a light-controlled display.

Use the circuit from project #467. Connect B, G, C, & F to the circuit. Turn on the switch (S1), the display should be off. Place your hand over the photoresistor (RP), now the number 4 lights.

Project #471

Automatic Display #5

OBJECTIVE: Light the number 5 using a light-controlled display.

Use the circuit from project #467. Connect A, C, F, G, & D to the circuit. Turn on the switch (S1), the display should be off. Place your hand over the photoresistor (RP), now the number 5 lights.

Project #472

Automatic Display #6

OBJECTIVE: Light the number 6 using a light-controlled display.

Use the circuit from project #467. Connect A, C, D, E, F, & G to the circuit. Turn on the switch (S1), the display should be off. Place your hand over the photoresistor (RP), now the number 6 lights.

Project #473

Automatic Display #7

OBJECTIVE: Light the number 7 using a light-controlled display.

Use the circuit from project #467. Connect A, B, & C to the circuit. Turn on the switch (S1), the display should be off. Place your hand over the photoresistor (RP), now the number 7 lights.

Project #474

Automatic Display #8

OBJECTIVE: Light the number 8 using a light-controlled display.

Use the circuit from project #467. Connect A, B, C, D, E, F & G to the circuit. Turn on the switch (S1), the display should be off. Place your hand over the photoresistor (RP), now the number 8 lights.

Project #475

Automatic Display #9

OBJECTIVE: Light the number 9 using a light-controlled display.

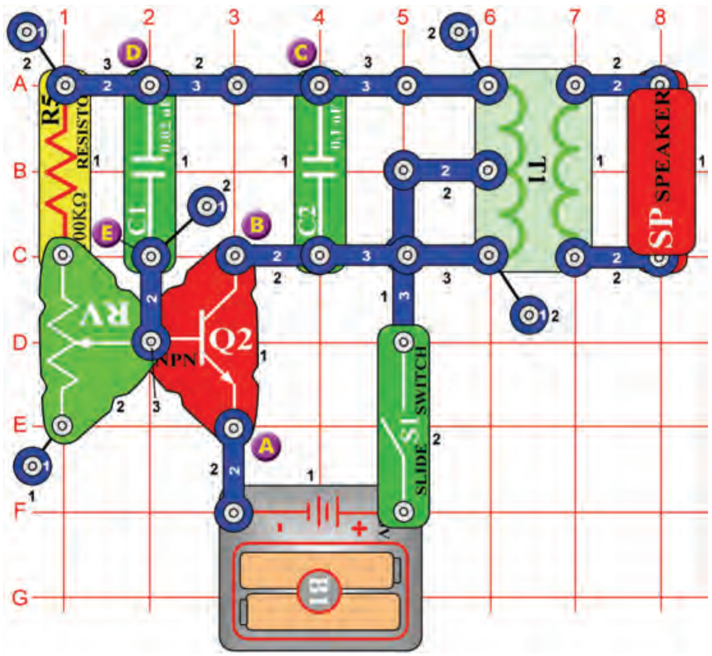
Use the circuit from project #467. Connect A, B, D, F, G, & C to the circuit. Turn on the switch (S1), the display should be off. Place your hand over the photoresistor (RP), now the number 9 lights.

Project #476

Automatic Display #0

OBJECTIVE: Light the number 0 using a light-controlled display.

Use the circuit from project #467. Connect A, B, C, D, E & F to the circuit. Turn on the switch (S1), the display should be off. Place your hand over the photoresistor (RP), now the number 0 lights.



Project #477
Variable Oscillator

OBJECTIVE: To change the tone using the adjustable resistor.

Set the adjustable resistor (RV) to the bottom position. Turn on the slide switch (S1) and you should hear sound from the speaker (SP). Adjust the resistor to hear the different sounds.

Project #478
Variable Oscillator (II)

OBJECTIVE: To change the tone using the adjustable resistor.

Use the circuit in project #477. Connect the whistle chip (WC) across points A & B and adjust the resistor (RV). You should hear a higher tone. This is generated by the whistle chip (WC).

Project #479
Variable Oscillator (III)

OBJECTIVE: Show variations of project #477.

Use the circuit in project #477. Connect the whistle chip (WC) across points B & C and adjust the resistor (RV).

Project #480
Variable Oscillator (IV)

OBJECTIVE: Show variations of project #477.

Use the circuit in project #477. Connect the whistle chip (WC) across points D & E and adjust the resistor (RV).

Project #481
Photo Variable Resistor

OBJECTIVE: Show variations of project #477.

Use the circuit in project #477. Replace the 100kΩ resistor (R5) with the photoresistor (RP). Wave your hand over the resistor and the sound changes. Adjust the resistor (RV) to make more sounds.

Project #482
Variable Whistle Chip Oscillator

OBJECTIVE: Show variations of project #477.

Use the circuit in project #477, remove the speaker (SP). Make three more sounds by placing the whistle chip (WC) across points, A & B, B & C, and D & E.

Project #483
Slow Adjusting Tone

OBJECTIVE: Show variations of project #477.

Use the circuit in project #477. Place the 10μF capacitor (C3) (+ towards the top) directly over the .02μF capacitor (C1). A tone is generated once or twice per second, depending on the resistor setting.

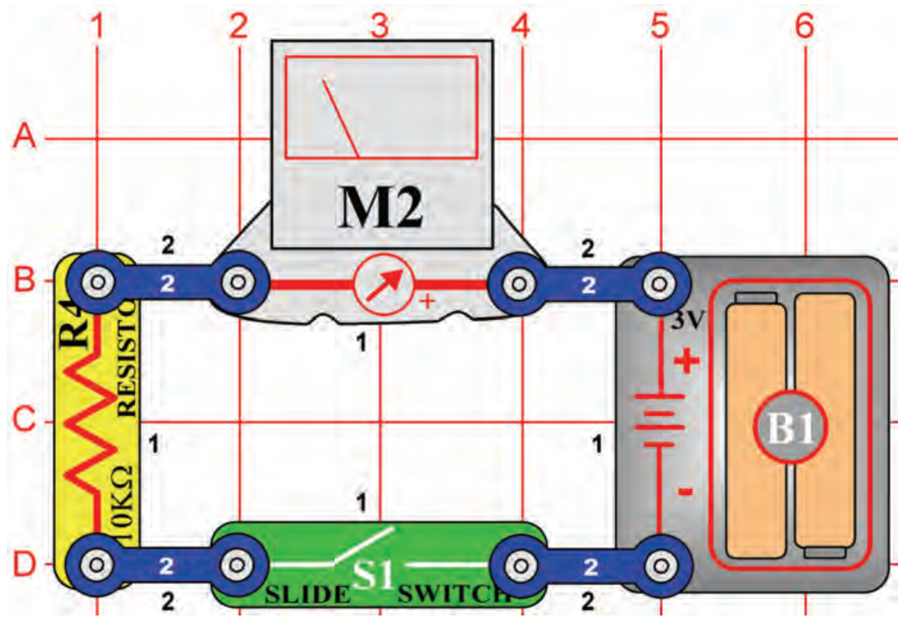
Project #484
Slow Adjusting Tone (II)

OBJECTIVE: Show a variation of project #483.

Use the circuit in project #483. Replace the 10μF capacitor (C3) with the 100μF capacitor (C4) and the tone is much slower. To make it even slower, replace the 100μF capacitor (C4) with the 470μF capacitor (C5).

Project #485 Fixed-Current Path

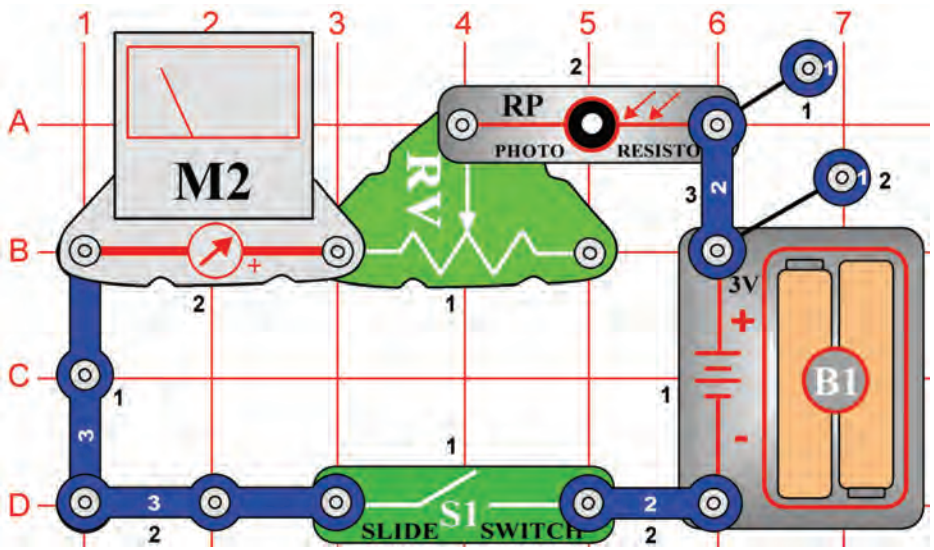
OBJECTIVE: To make a fixed-current path.



Set the meter (M2) to the LOW (or 10mA) setting. The meter indicates the amount of current in the circuit. Turn on the switch (S1), the needle deflects indicating the amount of current. The 10kΩ resistor limits the current, otherwise the meter could be damaged.

Project #486 Simple Illumination Meter

OBJECTIVE: To make a simple light meter.

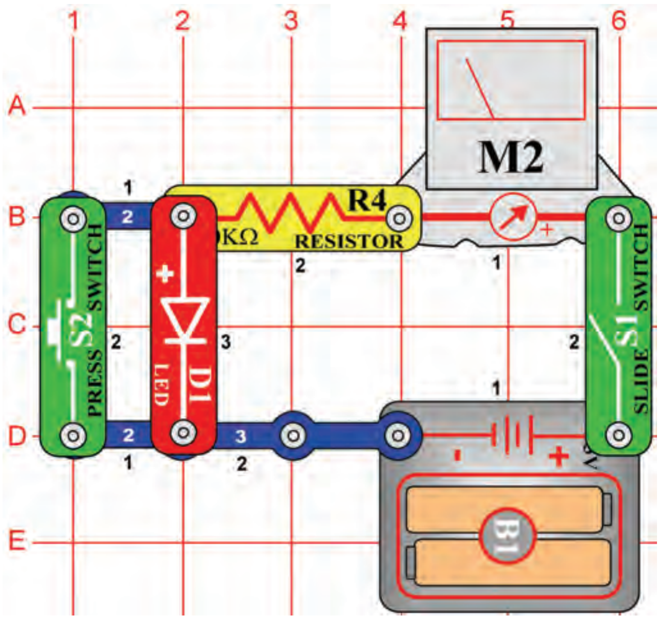


Set the meter (M2) to the LOW (or 10mA) setting. Using only a few parts, you can make a simple light meter. The amount of light changes the resistance of the photoresistor (RP), which affects the current though the meter. As light increases, the resistance drops and the meter deflects to the right. Decreasing the light, the meter deflects to the left, indicating less current.

Set the adjustable resistor (RV) to the far left and turn on the slide switch (S1). The circuit is now very sensitive to light. Wave your hand over the photoresistor (RP) and the meter deflects to the left, almost to zero. Move the adjustable resistor to the far right and see how less sensitive the circuit is to light now.

Project #487 — LED Voltage Drop

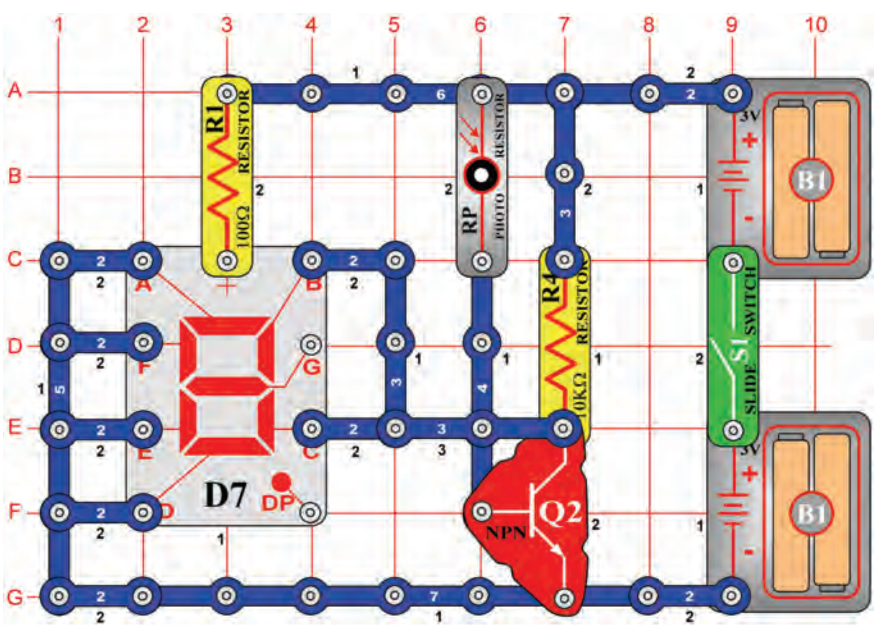
OBJECTIVE: To measure the voltage drop across diodes.



Set the meter (M2) to the LOW (or 10mA) setting. Turn on the slide switch (S1) and the LED (D1) lights as the meter deflects to the middle of the scale. The sum of the voltage drop across each components equals the battery voltage. Bypass the LED by pressing the switch (S2). The voltage across the 10kΩ resistor increases, as shown by the meter deflecting more to the right. Replace the red LED with the green LED (D2) and then the diode (D3), to see the different voltage drops.

Project #488 — Open/Closed Door Indicator

OBJECTIVE: To make a circuit that indicates whether a door is open or closed.



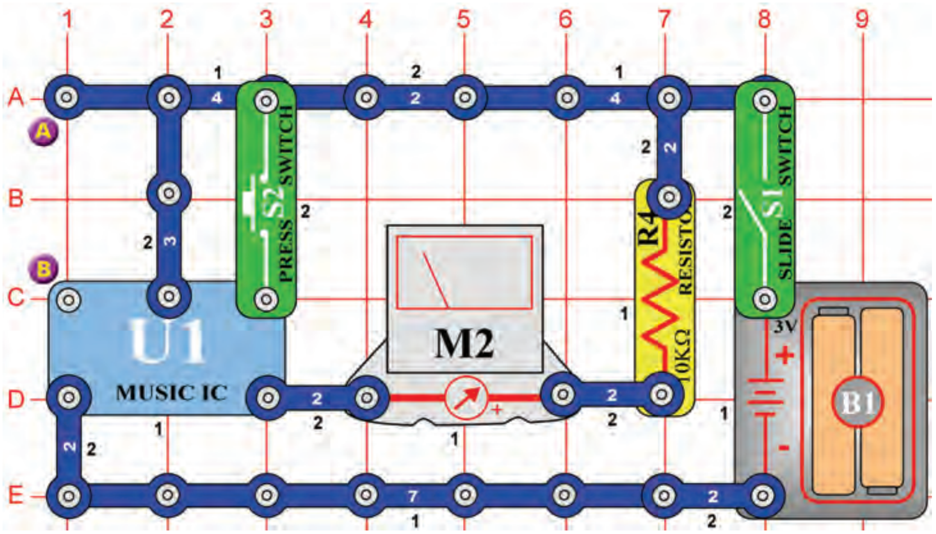
Using the photoresistor (RP) you can build a circuit that indicates if a door is open or closed. When the door is open and light is present, the letter "O" lights. When the door is closed and the room is dark, the letter C lights.

The photoresistor turns the transistor (Q2) on or off, depending on the amount of light in the room. When the transistor is on (light present), segments B & C connect to the (–) side of the batteries and letter "O" lights. When the room is dark, the transistor is off and the letter "C" lights. Segments B & C are connected to the transistor.

Turn the slide switch (S1) on and the letter "O" should light. Cover the photoresistor, simulating closing the door, and the letter "C" lights.

☐ Project #489 Hand-control Meter

OBJECTIVE: To understand music deflection.



Set the meter (M2) to the LOW (or 10mA) setting. Instead of driving a speaker (SP) with the music IC (U1), you can see it by using the meter. Turn on the slide switch (S1) and the meter deflects according to the rhythm of music. After the music stops, hold down the press switch (S2) to make it continue.

☐ Project #490 Light-control Meter

OBJECTIVE: To control the circuit using light.

Use the circuit in project #489. Replace the press switch (S2) with the photoresistor (RP). The music IC (U1) outputs a signal, as long as a light is present on the photoresistor. The photoresistor is like a short, connecting the pin to the battery. When the song repeats, cover the photoresistor with your hand, the resistance goes up, and the music stops.

☐ Project #491 Electric-control Meter

OBJECTIVE: To start the circuit using an electric motor.

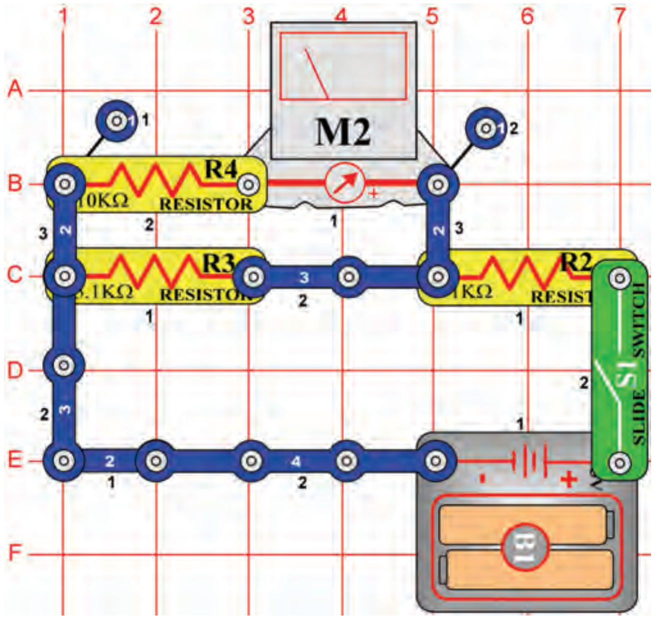
Use the circuit in project #489. Place the motor (M1) across points A & B. Turn on the slide switch (S1) and the meter (M2) deflects and swings according to the rhythm of music. When deflection stops, rotate motor to start the music again. The voltage generated by the motor triggers the IC again.

☐ Project #492 Sound-control Meter

OBJECTIVE: To start the circuit by using the whistle chip.

Use the circuit in project #489. Place the whistle chip (WC) across points A & B. Turn on the slide switch (S1) and the meter (M2) deflects and swings according to the rhythm of music. When deflection stops, clap your hands next to the whistle chip, the music plays again. The clapping sound vibrates the plates in the whistle chip, creating the voltage needed to trigger the IC.

Project #493 Fixed-Voltage Divider

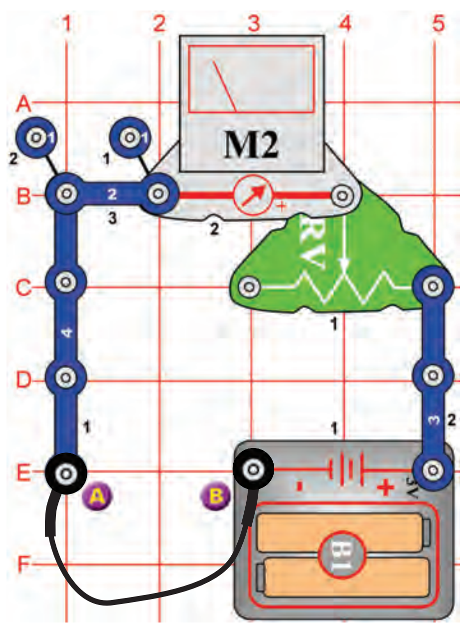


OBJECTIVE: To make a simple voltage divider.

Set the meter (M2) to the LOW (or 10mA) scale. This circuit is a simple voltage divider with parallel load resistors. The voltage across resistors R3 & R4 is the same. The current through both paths are different, due to the resistor values. Since resistor (R3) (5.1kΩ) is half the value of resistor (R4) (10kΩ), twice the current flows through R3.

The lights in a house are an example of this type of circuit. All are connected to the same voltage, but the current is dependent on the wattage of the bulb.

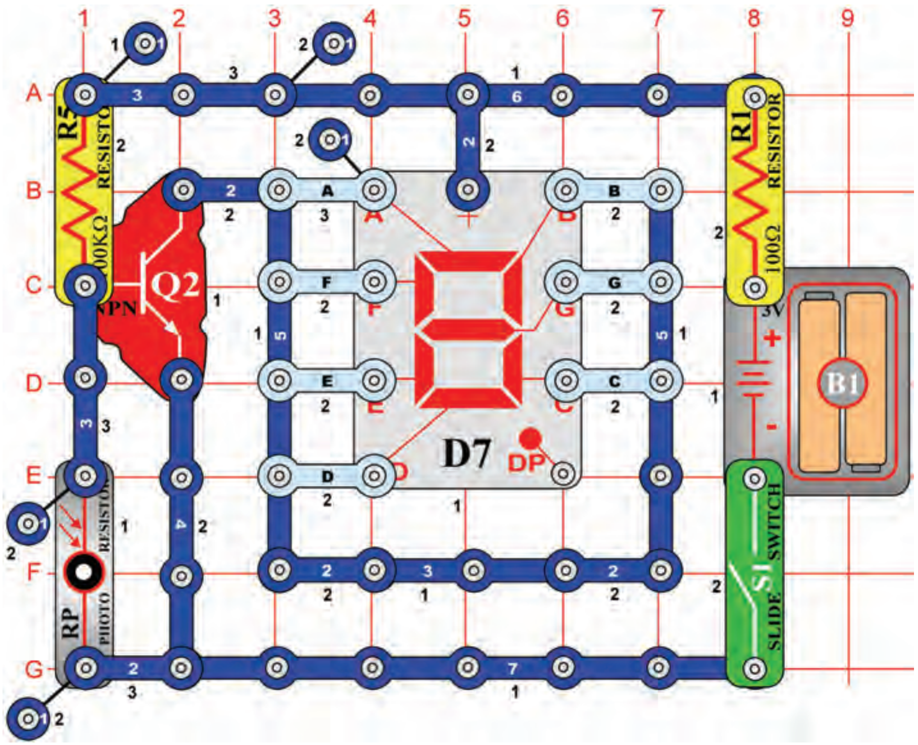
Project #494 Resistor Measurement



OBJECTIVE: To make a resistor checker.

Set the meter (M2) to the LOW (or 10mA) setting. Connect the jumper wire to points A & B. Adjust the adjustable resistor (RV) so the meter deflects to 10. The resistance between points A & B is zero. Remove the jumper wire and put the 100Ω resistor (R1) across points A & B. The meter deflects to the 10, indicating a low resistance. Now replace resistor (R1) with the other resistors. The meter will display different readings for each resistor.

To learn more about how circuits work, visit www.snapcircuits.net or page 62 to find out about our Student Guides.



Project #495

Automatic Display Letter "b"

OBJECTIVE: To construct a light-controlled display for lower case letters.

Connect C, D, E, F & G to the circuit. Turn on the slide switch (S1) and the display should be off. Place your hand over the photoresistor (RP), now the letter "b" lights.

Project #496

Automatic Display Letter "c"

OBJECTIVE: To light the letter "c" using a light-controlled display.

Use the circuit from project #495. Connect E, D, & G to the circuit. Turn on the slide switch (S1) and the display should be off. Place your hand over the photoresistor (RP), now the letter "c" lights.

Project #497

Automatic Display Letter "d"

OBJECTIVE: To light the letter "d" using a light-controlled display.

Use the circuit from project #495. Connect B, C, D, E, & G to the circuit. Turn on the slide switch (S1) and the display should be off. Place your hand over the photoresistor (RP), now the letter "d" lights.

Project #498

Automatic Display Letter "e"

OBJECTIVE: To light the letter "e" using a light-controlled display.

Use the circuit from project #495. Connect A, B, D, E, F, & G to the circuit. Turn on the slide switch (S1) and the display should be off. Place your hand over the photoresistor (RP), now the letter "e" lights.

Project #499

Automatic Display Letter "h"

OBJECTIVE: To light the letter "h" using a light-controlled display.

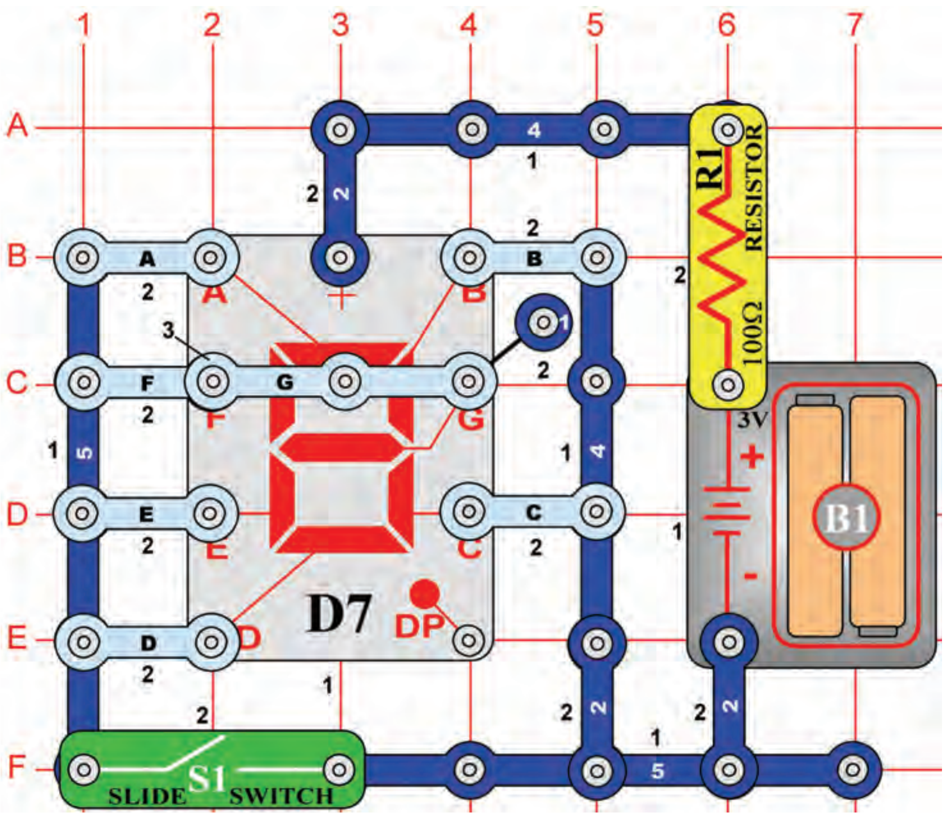
Use the circuit from project #495. Connect F, E, C, & G to the circuit. Turn on the slide switch (S1) the display should be off. Place your hand over the photoresistor (RP), now the letter "h" lights.

Project #500

Automatic Display Letter "o"

OBJECTIVE: To light the letter "o" using a light controlled display.

Use the circuit from project #495. Connect C, D, E, and G to the circuit. Turn on the slide switch (S1) the display should be off. Place your hand over the photoresistor (RP), now the letter "o" lights.



Project #501

Hand-Control Display 1 & 4

OBJECTIVE: Display numbers 1 or 4 using the slide switch.

Connect segments B, C, F, & G as shown in the diagram. Turn the slide switch (S1) off and on, the display changes from numbers 1 to 4.

Project #502

Hand-Control Display 1 & 0

OBJECTIVE: Display numbers 1 or 0 using the slide switch.

Connect segments A, B, C, D, E, & F as shown in the diagram. Turn the slide switch (S1) off and on, the display changes from numbers 1 to 0.

Project #503

Hand-Control Display 1 & 7

OBJECTIVE: Display numbers 1 or 7 using the slide switch.

Connect segments A, B, & C as shown in the diagram. Turn the slide switch (S1) off and on, the display changes from numbers 1 to 7.

Project #504

Hand-Control Display 1 & 8

OBJECTIVE: Display numbers 1 or 8 using the slide switch.

Connect segments A, B, C, D, E, F, & G as shown in the diagram. Turn the slide switch (S1) off and on, the display changes from numbers 1 to 8.

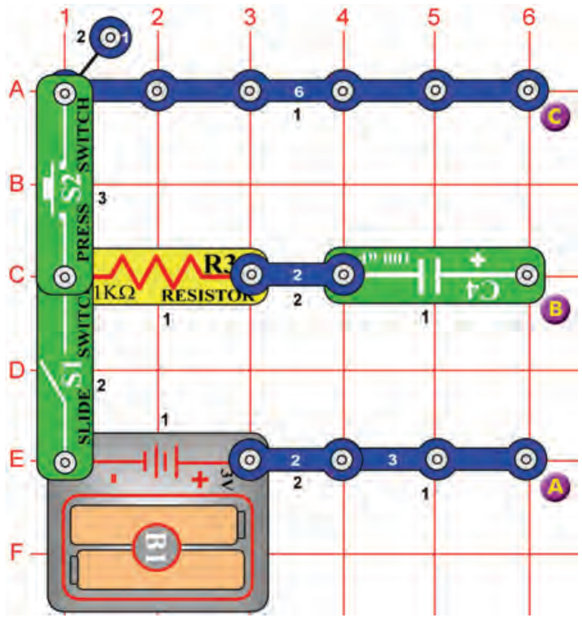
Project #505

Hand-Control Display 1 & 9

OBJECTIVE: Display numbers 1 or 9 using the slide switch.

Connect segments A, B, C, D, F, & G as shown in the diagram. Turn the slide switch (S1) off and on, the display changes from numbers 1 to 9.

Project #506



Monitor Capacitor Charging & Discharging

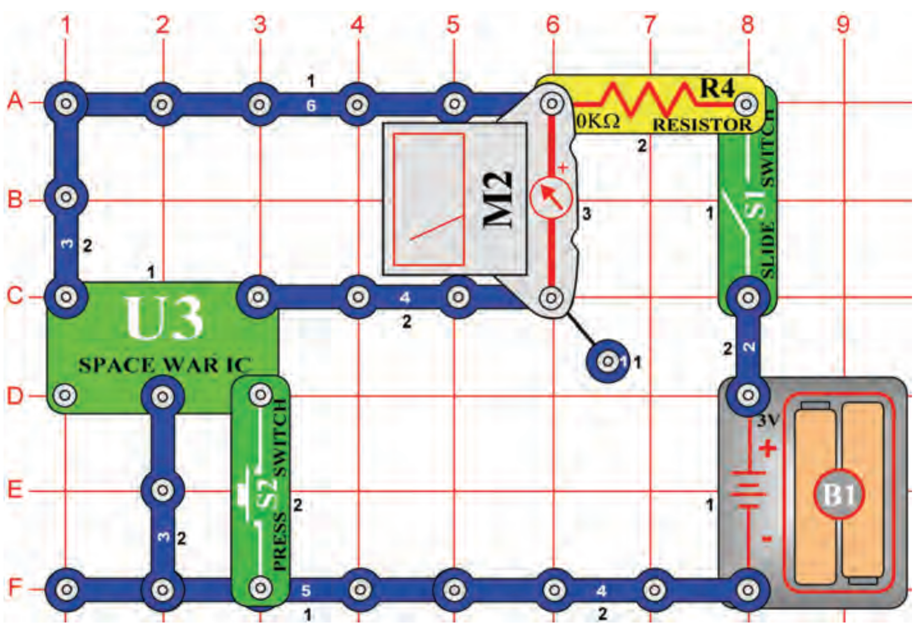
OBJECTIVE: View charging and discharging a capacitor.

Using the meter (M2), we can monitor the charging and discharging of a capacitor. First turn off the switch (S1).

Charging: Connect the meter (M2) to points A & B (positive pole downward). Turn on the switch (S1). The 100μF capacitor (C4) charges and the meter deflects, slowly returning to zero.

Discharging: Connect the meter to points B & C (positive pole downward). Press the switch (S2). The capacitor discharges and the meter deflects, slowly returning to zero.

Project #507



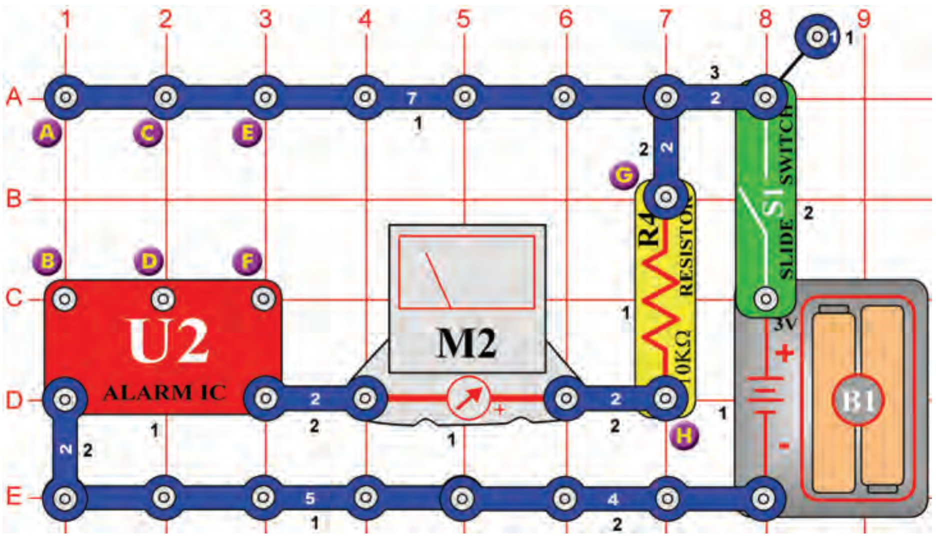
Hand-Control Space Meter

OBJECTIVE: Using the meter with the space war IC.

Set the meter (M2) to the LOW (or 10mA) setting. This is another circuit using the meter to monitor the output of an IC.
Turn on the switch (S1). Press switch (S2) to start the circuit. As the space war IC (U3) outputs a signal, the meter will deflect. When the circuit stops, start it again by pressing switch (S2).

Project #508 — Rhythm Swinging Meter

OBJECTIVE: Use the meter with the alarm IC.



Set the meter (M2) to the LOW (or 10mA) setting. Connect 3-snap wires to terminals E & F, and C & D. Turn on the slide switch (S1) and the meter swings rhythmically.

Project #509 — Police Car Sound with Whistle Chip

OBJECTIVE:
Show variations of project #508.

Use the circuit in project #508. Connect the whistle chip (WC) to points G & H. Connect a 3-wire snap to the terminals C & D and turn on the switch (S1).

Project #510 — Fire Engine Sound with Whistle Chip

OBJECTIVE:
Show variations of project #508.

Connect 3-wire snaps to terminals C & D and A & B. Connect the whistle chip (WC) across points G & H. You should hear a fire engine sound generated by the alarm IC (U2).

Project #511 — Ambulance Sound with Whistle Chip

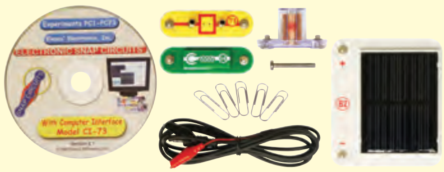
OBJECTIVE:
Show variations of project #508.

Connect a 3-wire snap to terminals C & D. Connect the whistle chip (WC) across points G & H. Connect a jumper wire to terminals B & H. You should hear an ambulance sound generated by the alarm IC (U2).

OTHER SNAP CIRCUITS® PRODUCTS!

For a listing of local toy retailers who carry Snap Circuits®, please visit **www.elenco.com** or call us toll-free at (800) 533-2441. For Snap Circuits® upgrade kits, accessories, additional parts, and more information about your parts, please visit **www.snapcircuits.net**.

Upgrade Kit
Model UC-80



Build 250 Additional Projects
Including:
- Strobe light
- Electromagnetism
- Transistor AM radio
- Rechargeable battery
- Solar batteries
- Mega pulser and flasher
- Paperclip compass

Contains 10 New Parts
Including:
- Solar cell
- Electromagnet
- Vibration switch
- Two-spring socket
- Bag of paperclips

- Plus all experiments contained in the 500-in-1 (SC-500)!
- Includes CI-73 Computer Interface!

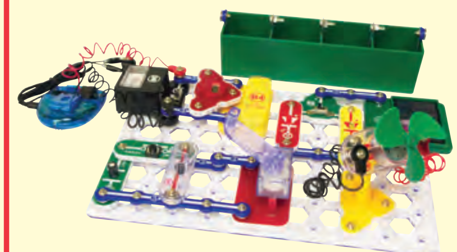
Put your circuits in motion!
Deluxe Snap Rover®
Model SCROV-50

Introducing the next generation of the RC Snap Rover®! This version includes a disc launcher, digital voice recorder, and music sounds. Over 50 parts allow you to complete over 40 additional projects.

- **Includes 30 parts**
- **Build over 20 projects**
- **Full-color assembly manual**
- **Sound effects**

Snap Circuits® Green
Alternative Energy Kit
Model SCG-125

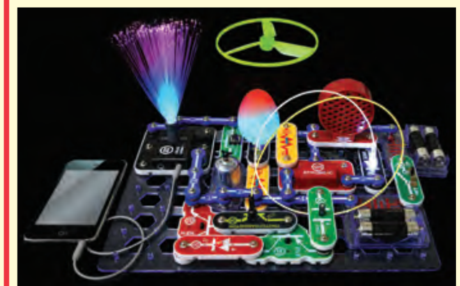
Learn about energy sources and how to "think green". Build over 125 projects and have loads of fun learning about environmentally-friendly energy and how the electricity in your home works. Includes full-color manual with over 100 pages and separate educational manual. This educational manual will explain all the forms of environmentally-friendly energy including: geothermal, hydrogen fuel cells, wind, solar, tidal, hydro, and others. Contains over 40 parts.



Snap Circuits® LIGHT
Model SCL-175

Build over 175 projects! **Contains over 60 parts**

Features:
- Infrared detector
- Strobe light
- Color changing LED
- Glow-in-the-dark fan
- Strobe integrated circuit (IC)
- Fiber optic communication
- Color organ controlled by iPod® or other MP3 player, voice, and fingers.



Motion Detector
Model SCP-03

Whenever somebody walks in front of the Motion Detector, the sound of a laser comes out of the speaker!

Snaptricity
Model SCBE-75
Build Over 75 Projects

Learn how electricity and magnetism can be used to make each other, learn about magnetic fields, how the electricity in your home works, how switches control the electricity to the lights in your home, and how series and parallel circuits affect electricity.

Over 40 parts including: Meter, electromagnet, motor, lamps, switches, fan, compass, and electrodes.

Educational Toy: Projects that relate to electricity in the home and magnetism and how it is used. Build over 75 projects.

If you want to enhance your Snap Circuits® experience and get even smarter, then try

Snap Circuits® Student Guide
Part # 753307
For use with SC-500

Educational Series - teaches Basic Electricity and Electronics in the everyday world using our Learn By Doing® concept!
80 full-color pages, and written with the help of educators.

Custom Storage Case
Model SNAPCASE7

Heavy duty plastic case with 2 custom foam inserts for housing your Snap Circuits® parts. Easy to identify missing components. Also includes a separate small case to hold the smaller loose parts.

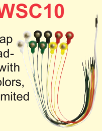
(for use with SC-500)

Expansion Parts

AC Power Supply
Part # AC-SNAP

Replaces the batteries in Snap Circuits®.

Snap-to-Pin Set
Part # 9JWSC10



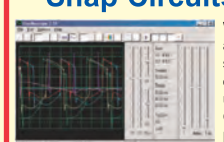
Lets you connect Snap Circuits® to a bread-board. 10 wires with reinforced pins, 5 colors, 10" length, and unlimited possibilies!

Two-spring Socket
Part # ?1

Three-spring Socket
Part # ?Q

Eight-Pin IC Socket
Part # ?U8

Computer Interface for Snap Circuits® Model CI-73



Sample Screen of Computer Experiment

With this module you will also learn about and use an oscilloscope and spectrum analyzer, as you build over ***73 BONUS EXPERIMENTS*** using your Windows-based PC. Comes with all of the interface parts you need and the software. Great for introducing electronics through a computer. Works with all versions of our Snap Circuits®.

Acts as a Scope and Allows You to See the Signals in the Circuit.

OTHER FUN ELENCO® PRODUCTS

RC Car Kit
Model FUN-875

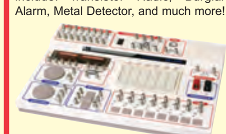
Your Turbo King Car will be built from the ground up. You'll learn all about gears, motors, printed circuit boards, and integrated circuits from our detailed assembly and training manual. You will construct each section, explore the circuitry and troubleshoot it.

Titan Tank Kit
Model 21-531N

The Titan Tank is an infrared remote control kit. Its microprocessor provides four different channels that allow up to four Titans to fight each other at the same time. Makes a sound when shooting and when it is hit. The Titan moves using six wheels that can move forward, backward, right and left.

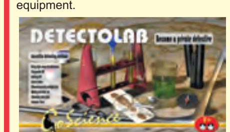
300-in-1 Project Lab
Model MX-908

This lab has everything you need to build 300 exciting electronic projects. It uses spring and breadboard hook-up methods and includes an easy-to-read, illustrated, lab-style manual. Projects include: Transistor Radio, Burglar Alarm, Metal Detector, and much more!



Detectolab
Model EDU-7080

Investigate, analyze, decipher and solve the crime! Over 65 activities with fingerprints, secret messages, chroma-tography, cipher codes, identity detection and more... Kit includes 30X microscope and necessary lab equipment.



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e-mail: elenco@elenco.com

ELECTRONIC SNAP CIRCUITS®

Projects 512-692

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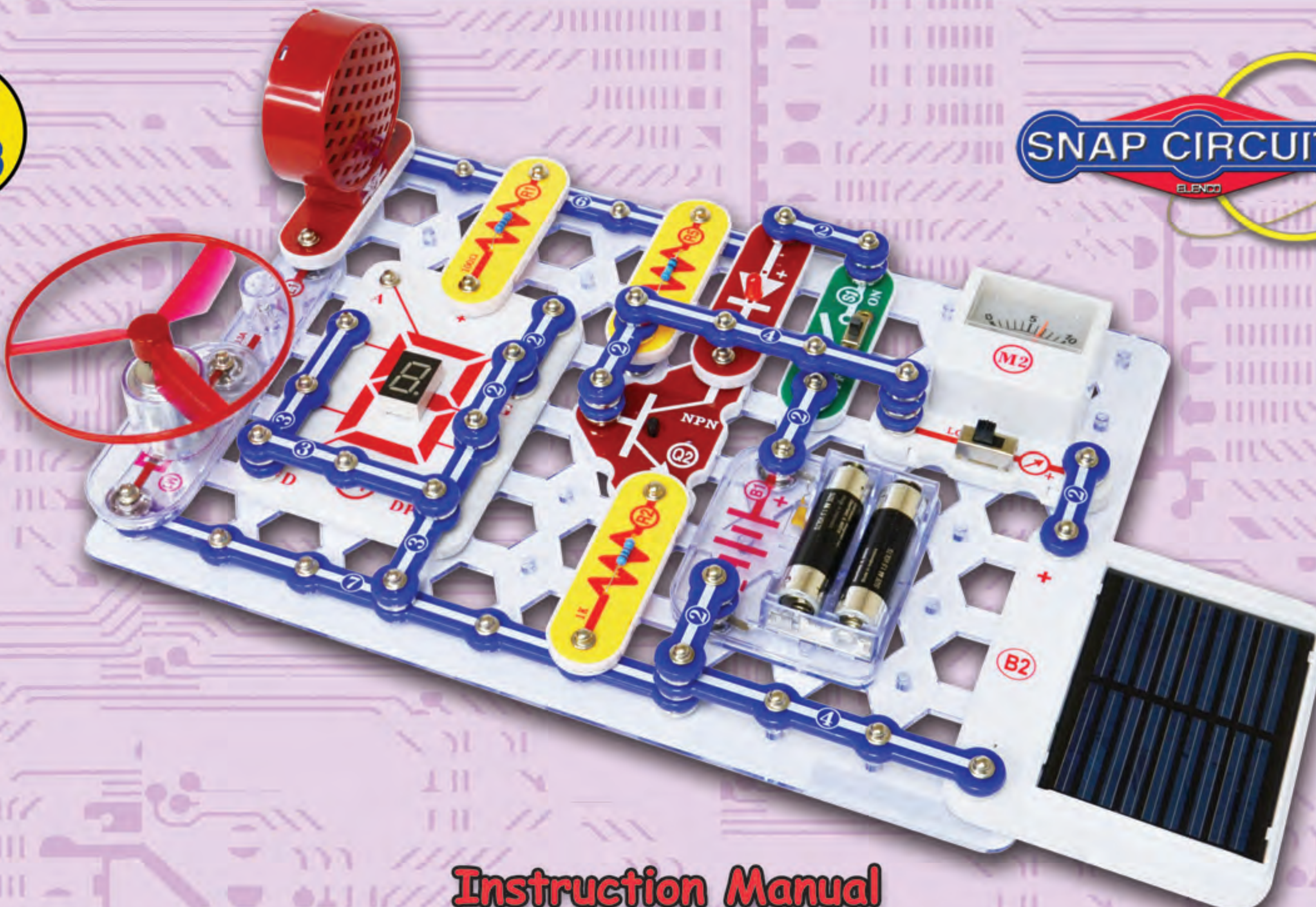
SNAP CIRCUITS®



Project 526

Instruction Manual

ELENCO®

REV-E Revised 2012 753292

Table of Contents

Basic Troubleshooting

1. **Most circuit problems are due to incorrect assembly. Always double-check that your circuit exactly matches the drawing for it.**
2. **Be sure that parts with positive/negative markings are positioned as per the drawing.**
3. **Be sure that all connections are securely snapped.**
4. **Try replacing the batteries.**
5. **If the motor spins but does not balance the fan, check the black plastic piece with three prongs on the motor shaft. Be sure that it is at the top of the shaft.**

Elenco® is not responsible for parts damaged due to incorrect wiring.

Note: If you suspect you have damaged parts, you can follow the Advanced Troubleshooting procedure on page 4 to determine which ones need replacing.

WARNING: SHOCK HAZARD - Never connect Snap Circuits® to the electrical outlets in your home in any way!

WARNING: CHOKING HAZARD - Small parts. Not for children under 3 years.

WARNING FOR ALL PROJECTS WITH A ⚠ SYMBOL Moving parts. Do not touch the motor or fan during operation. Do not lean over the motor. Do not launch the fan at people, animals, or objects. Eye protection is recommended.

Batteries:

- Use only 1.5V AA type, alkaline batteries (not included).
- Insert batteries with correct polarity.
- Non-rechargeable batteries should not be recharged. Rechargeable batteries should only be charged under adult supervision, and should not be recharged while in the product.
- Do not mix alkaline, standard (carbon-zinc), or rechargeable (nickel-cadmium) batteries.
- Do not mix old and new batteries.
- Remove batteries when they are used up.
- Do not short circuit the battery terminals.
- Never throw batteries in a fire or attempt to open its outer casing.
- Batteries are harmful if swallowed, so keep away from small children.
- Do not connect batteries or battery holders in parallel.

WARNING: Always check your wiring before turning on a circuit. Never leave a circuit unattended while the batteries are installed. Never connect additional batteries or any other power sources to your circuits. Discard any cracked or broken parts.

Adult Supervision: Because children's abilities vary so much, even with age groups, adults should exercise discretion as to which experiments are suitable and safe (the instructions should enable supervising adults to establish the experiment's suitability for the child). Make sure your child reads and follows all of the relevant instructions and safety procedures, and keeps them at hand for reference.

This product is intended for use by adults and children who have attained sufficient maturity to read and follow directions and warnings.

Never modify your parts, as doing so may disable important safety features in them, and could put your child at risk of injury.

Review of How To Use It (See page 3 of the Projects 1-101 manual for more details.)

The Snap Circuits® kit uses building blocks with snaps to build the different electrical and electronic circuits in the projects. These blocks are in different colors and have numbers on them so that you can easily identify them. The circuit you will build is shown in color and with numbers, identifying the blocks that you will use and snap together to form a circuit.

Next to each part in every circuit drawing is a small number in black. This tells you which level the component is placed at. Place all parts on level 1 first, then all of the parts on level 2, then all of the parts on level 3, etc.

A large clear plastic base grid is included with this kit to help keep the circuit block together. The base has rows labeled A-G and columns labeled 1-10.

Install two (2) "AA" batteries (not included) in the battery holder (B1). The 2.5V and 6V bulbs come packaged separate from their sockets. Install the 2.5V bulb in the L1 lamp socket, and the 6V bulb in the L2 lamp socket.

Place the fan on the motor (M1) whenever that part is used, unless the project you are building says not to use it.

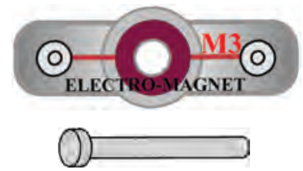
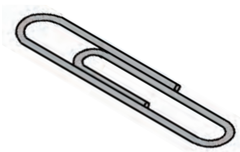
Some circuits use the red and black jumper wires to make unusual connections. Just clip them to the metal snaps or as indicated.

Note: While building the projects, be careful not to accidentally make a direct connection across the battery holder (a "short circuit"), as this may damage and/or quickly drain the batteries.

Parts List (Colors and styles may vary) Symbols and Numbers

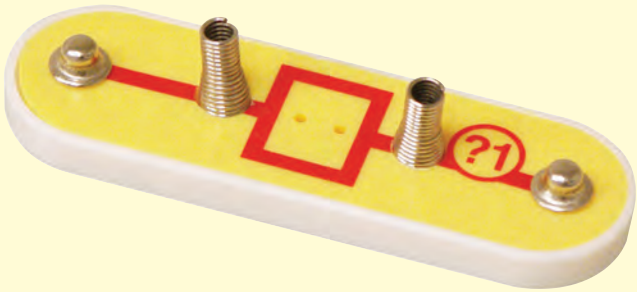
Note: There are additional part lists in your other project manuals. Part designs are subject to change without notice.

Important: If any parts are missing or damaged, **DO NOT RETURN TO RETAILER**. Call toll-free (800) 533-2441 or e-mail us at: help@elenco.com. Customer Service • 150 Carpenter Ave. • Wheeling, IL 60090 U.S.A.

Qty.	ID	Name	Symbol	Part #
❒ 1	(B2)	Solar Cell		6SCB2
❒ 1 ❒ 1	(M3)	Electromagnet Iron Core Rod		6SCM3 6SCM3B
❒ 1	(S4)	Vibration Switch		6SCS4
❒ 1		Bag of Paperclips		6SCM3P
❒ 1	(?1)	Two-spring Socket		6SCPY1

You may order additional / replacement parts at our website: www.snapcircuits.net

About the TWO-SPRING SOCKET (?1)

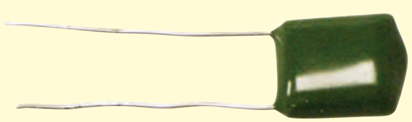


The two-spring socket (?1) just has two springs, and won't do anything by itself. It is not used in any of the experiments. It was included to make it easy to connect other electronic components to your Snap Circuits®. It should only be used by advanced users who are creating their own circuits.

There are many different types of electronic components and basic parts like resistors and capacitors have a wide range of available values. For example, Snap Circuits® includes five fixed-value resistors (100Ω, 1KΩ, 5.1KΩ, 10KΩ, and 100KΩ). This is a very limited choice of values, and difficult to design circuits with. Snap Circuits® also includes a adjustable resistor (RV), but it is difficult to set this part to a particular value. You can place your resistors in series and parallel to make different values (as is done with the 5.1KΩ and 10KΩ in project #166), but this is also difficult with only five values to choose from.

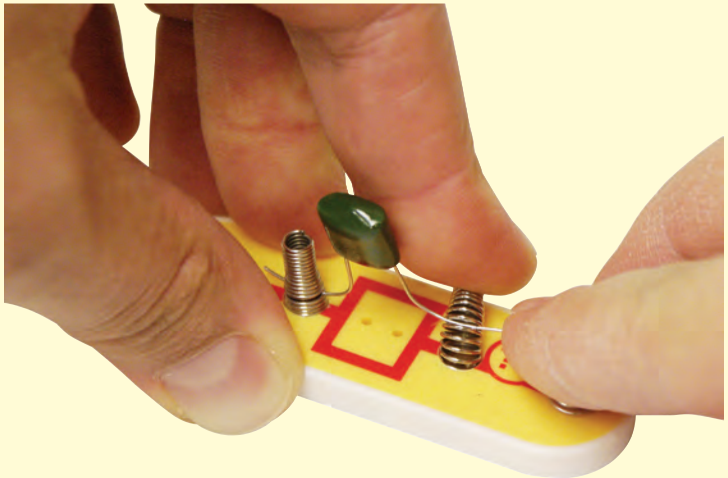
Many customers like to create their own circuits and asked us to include more resistor values with Snap Circuits®. We could have done that, but you would never have enough. And resistors are not very exciting components by themselves. You could try to use your own resistors, but they are difficult to connect since normal electronic parts come with wires on them instead of snaps.

Resistor



Capacitor

The two-spring socket (?1) makes it easy to connect your own resistors (and other parts) to circuits by connecting them between the springs:



Any component with two wires coming from it (called leads) can be connected with the two-spring socket (?1), assuming the leads are long enough. Usually you will connect different values of resistors or capacitors, but other components like LED's, diodes, or coils/inductors can also be used. You can usually find electronic components at any store specializing in electronics.

You can design your own circuits or substitute new parts into the projects in the manuals. For LED's, diodes, or electrolytic capacitors, be sure to connect your parts using the correct polarity or you may damage them. Never exceed the voltage ratings of any parts. Never connect to external voltage sources. ELENCO® IS NOT RESPONSIBLE FOR ANY PARTS DAMAGED BY IMPROPER CIRCUIT DESIGN OR WIRING. **The two-spring socket is only intended for advanced users.**

To learn more about how circuits work, visit www.snapcircuits.net or page 85 to find out about our Student Guides.

MORE About Your Snap Circuits® Parts

(Note: There is additional information in your other project manuals).

Our Student Guides give much more information about your parts, along with a complete lesson in basic electronics. See www.snapcircuits.net/learn.htm for more information.

The **solar cell (B2)** contains positively and negatively charged silicon crystals, arranged in layers that cancel each other out. When sunlight shines on it, charged particles in the light unbalance the silicon layers and produce an electrical voltage (about 3V). The maximum current depends on how the type of light and its brightness, but will be much less than a battery can supply. Bright sunlight works best, but incandescent light bulbs also work.

The **electromagnet (M3)** is a large coil of wire, which acts like a magnet when a current flows through it. Placing an iron bar inside increases the magnetic effects. Note that magnets can erase magnetic media like floppy discs.

When shaken, the **vibraton switch (S4)** contains two separate contacts; and a spring is connected to one of them. A vibration causes the spring to move, briefly connecting the two contacts.

The **two-spring socket (?1)** is described on page 3.

A Note on Sun Power

The sun produces heat and light on an immense scale, by transforming Hydrogen gas into Helium gas. This "transformation" is a thermonuclear reaction, similar to the explosion of a Hydrogen bomb. The earth is protected from most of this heat and radiation by being so far away, and by its atmosphere. But even here the sun still has power, since it can spin the motor on your kit and give you sunburn on a hot day.

Nearly all of the energy in any form on the surface of the earth originally came from the sun. Plants get energy for growth from the sun using a process called photosynthesis. People and animals get energy for growth by eating plants (and other animals). Fossil fuels such as oil and coal that power most of our society are the decayed remains of plants from long ago. These fuels exist in large but limited quantity, and are rapidly being consumed. Solar cells will produce electricity as long as the sun is bright, and will have an ever-increasing effect on our lives.

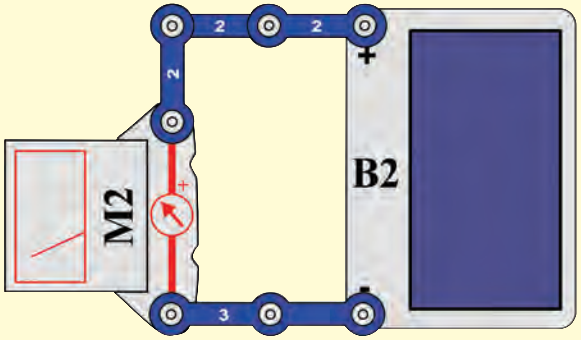
MORE Advanced Troubleshooting (Adult supervision recommended)

Elenco® is not responsible for parts damaged due to incorrect wiring.

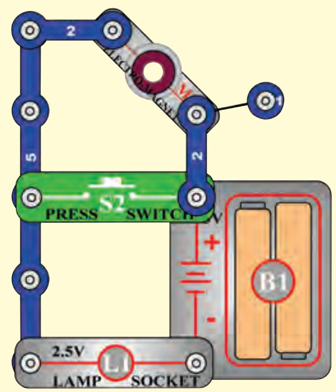
If you suspect you have damaged parts, you can follow this procedure to systematically determine which ones need replacing:

1 - 28. Refer to the other project manuals for testing steps 1-28, then continue below.

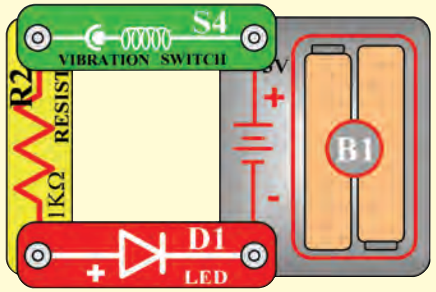
29. **Solar Cell (B2):** Build the mini-circuit shown here and set the meter (M2) to the LOW (or 10mA) setting. Hold the circuit near a lamp and the meter pointer should move.



30. **Electromagnet (M3):** Build the mini-circuit shown here. Lamp (L1) must be dim, and must get brighter when you press the press switch (S2).



31. **Vibration Switch (S4):** Build the mini-circuit shown here and shake the base grid. The LED should go on and off as you shake.



MORE DO's and DON'Ts of Building Circuits

After building the circuits given in this booklet, you may wish to experiment on your own. Use the projects in this booklet as a guide, as many important design concepts are introduced throughout them. Every circuit will include a power source (the batteries), a resistance (which might be a resistor, lamp, motor, integrated circuit, etc.), and wiring paths between them and back. You must be careful not to create "short circuits" (very low-resistance paths across the batteries, see examples below) as this will damage components and/or quickly drain your batteries. Only connect the IC's using configurations given in the projects, incorrectly doing so may damage them. **Elenco® is not responsible for parts damaged due to incorrect wiring.**

Here are some important guidelines:

ALWAYS **USE EYE PROTECTION WHEN EXPERIMENTING ON YOUR OWN.**

ALWAYS include at least one component that will limit the current through a circuit, such as the speaker, lamp, whistle chip, capacitors, ICs (which must be connected properly), motor, microphone, photo resistor, or fixed resistors.

ALWAYS use the **7-segment display**, LED's, transistors, the high frequency IC, the **SCR**, the antenna, and switches **in conjunction with other components that will limit the current through them**. Failure to do so will create a short circuit and/or damage those parts.

ALWAYS connect the adjustable resistor so that if set to its 0 setting, the current will be limited by other components in the circuit.

ALWAYS connect position capacitors so that the "+" side gets the higher voltage.

ALWAYS disconnect your batteries immediately and check your wiring if something appears to be getting hot.

ALWAYS check your wiring before turning on a circuit.

ALWAYS **connect ICs, the FM module, and the SCR using configurations given in the projects or as per the connection descriptions for the parts.**

NEVER try to use the high frequency IC as a transistor (the packages are similar, but the parts are different).

NEVER use the 2.5V lamp in a circuit with both battery holders unless you are sure that the voltage across it will be limited.

NEVER connect to an electrical outlet in your home in any way.

NEVER leave a circuit unattended when it is turned on.

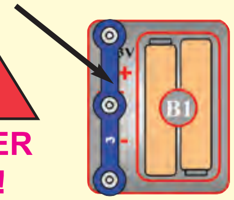
NEVER touch the motor when it is spinning at high speed.

For all of the projects given in this book, the parts may be arranged in different ways without changing the circuit. For example, the order of parts connected in series or in parallel does not matter — what matters is how combinations of these sub-circuits are arranged together.

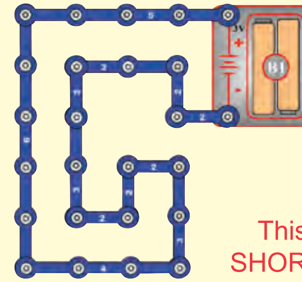
Warning to Snap Rover owners: Do not connect your parts to the Rover body except when using our approved circuits, the Rover body has a higher voltage which could damage your parts.

Examples of SHORT CIRCUITS - NEVER DO THESE!!!

Placing a 3-snap wire directly across the batteries is a SHORT CIRCUIT.



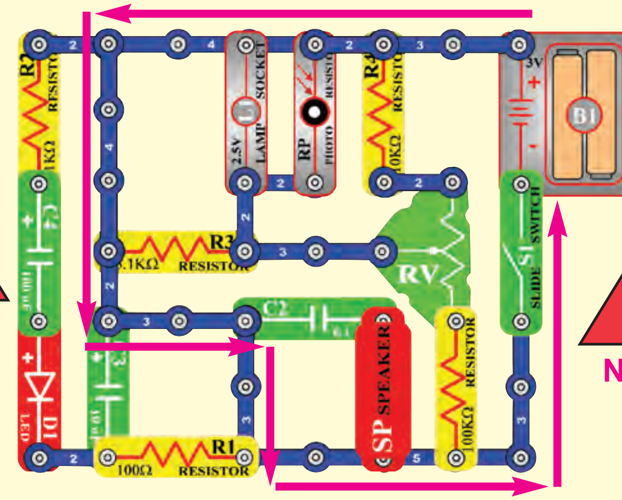
NEVER DO!



NEVER DO!

This is also a SHORT CIRCUIT.

When the slide switch (S1) is turned on, this large circuit has a SHORT CIRCUIT path (as shown by the arrows). The short circuit prevents any other portions of the circuit from ever working.



NEVER DO!

NEVER DO!

You are encouraged to tell us about new circuits you create. If they are unique, we will post them with your name and state on our website at **www.snapcircuits.net/kidkreations.htm**. Send your suggestions to ELENCO®.

Elenco® provides a circuit designer so that you can make your own Snap Circuits® drawings. This Microsoft® Word document can be downloaded from **www.snapcircuits.net/SnapDesigner.doc** or through the **www.snapcircuits.net** web site.

WARNING: SHOCK HAZARD - Never connect Snap Circuits® to the electrical outlets in your home in any way!

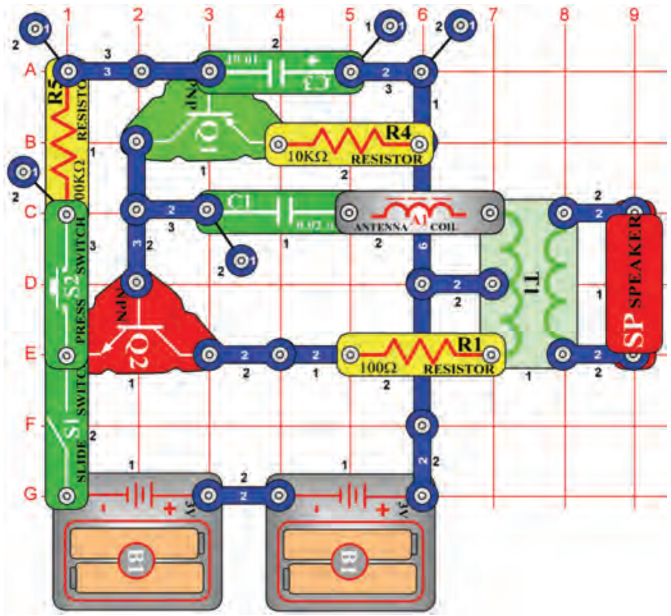
Project Listings

To learn more about how circuits work, visit www.snapcircuits.net or page 85 to find out about our Student Guides.

Project Listings

☐ Project #512 Siren

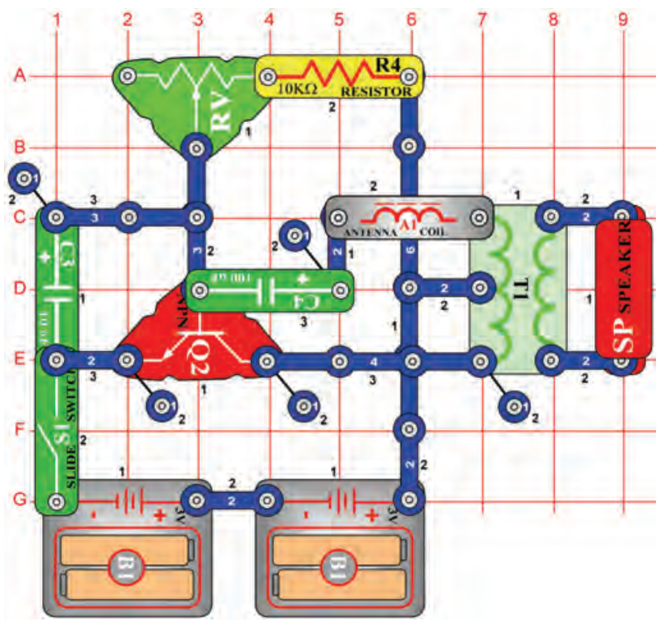
OBJECTIVE: To make a siren that slowly starts up and fades away.



Turn on the slide switch (S1), and then press the press switch (S2) for a few seconds and release. A siren starts up and then slowly fades away as the 10μF capacitor (C3) discharges.

☐ Project #513 Electronic Rain

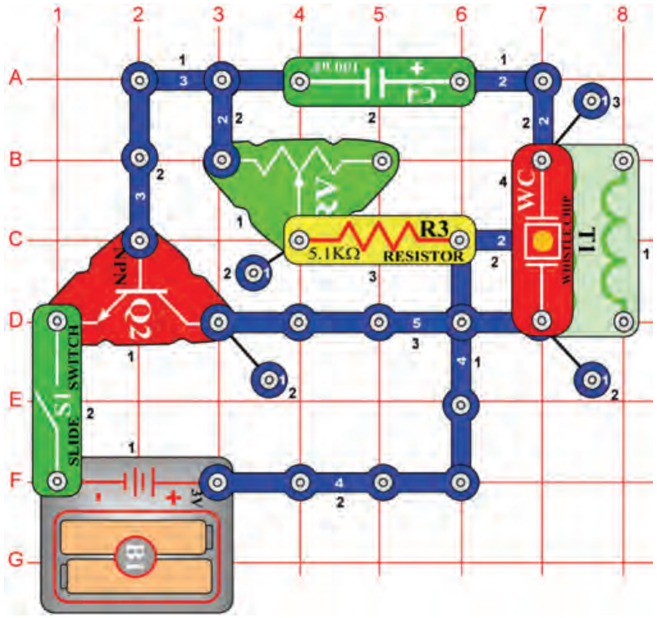
OBJECTIVE: To make a low-frequency oscillator.



Build the circuit and turn on the slide switch (S1), you hear a sound like raindrops. The adjustable resistor (RV) controls the rain. Turn it to the left to make a drizzle and turn to the right to make the rain come pouring down.

You can replace the 10KΩ resistor (R4) with the 1KΩ (R2) or 5.1KΩ (R3) resistors to speed up the rain.

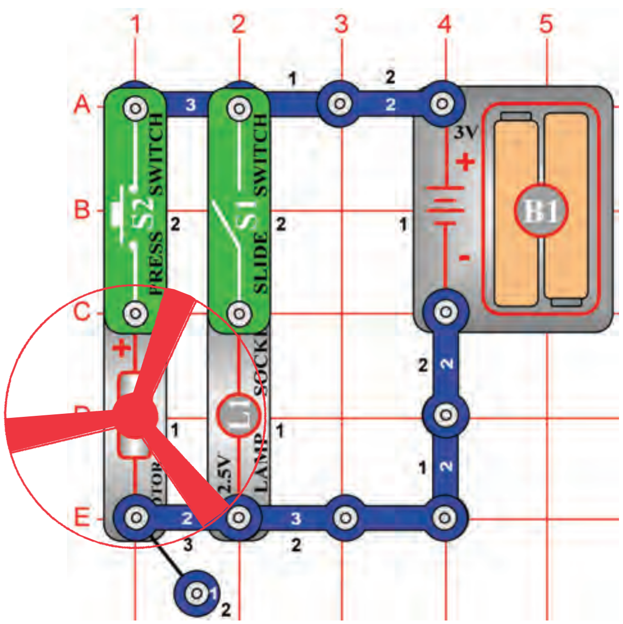
Project #514 Leaky Faucet



OBJECTIVE: To make a low-frequency oscillator.

Build the circuit and set the adjustable resistor (RV) control all the way to the right. Turn on the slide switch (S1) and you hear a sound like a faucet dripping. You can speed up the dripping by moving the adjustable resistor control around.

Project #515 Lamp & Fan Independent



OBJECTIVE: To show how switches allow circuits to operate independently even though they have the same power source.

This circuit combines projects #1, #2, and #6 into one circuit.

Build the circuit and place the fan on the motor (M1). Depending on which of the switches (S1 & S2) are on, you can turn on either the lamp (project #1), the motor (project #2), or both together (project #6).

WARNING: Moving parts. Do not touch the fan or motor during operation. Do not lean over the motor.

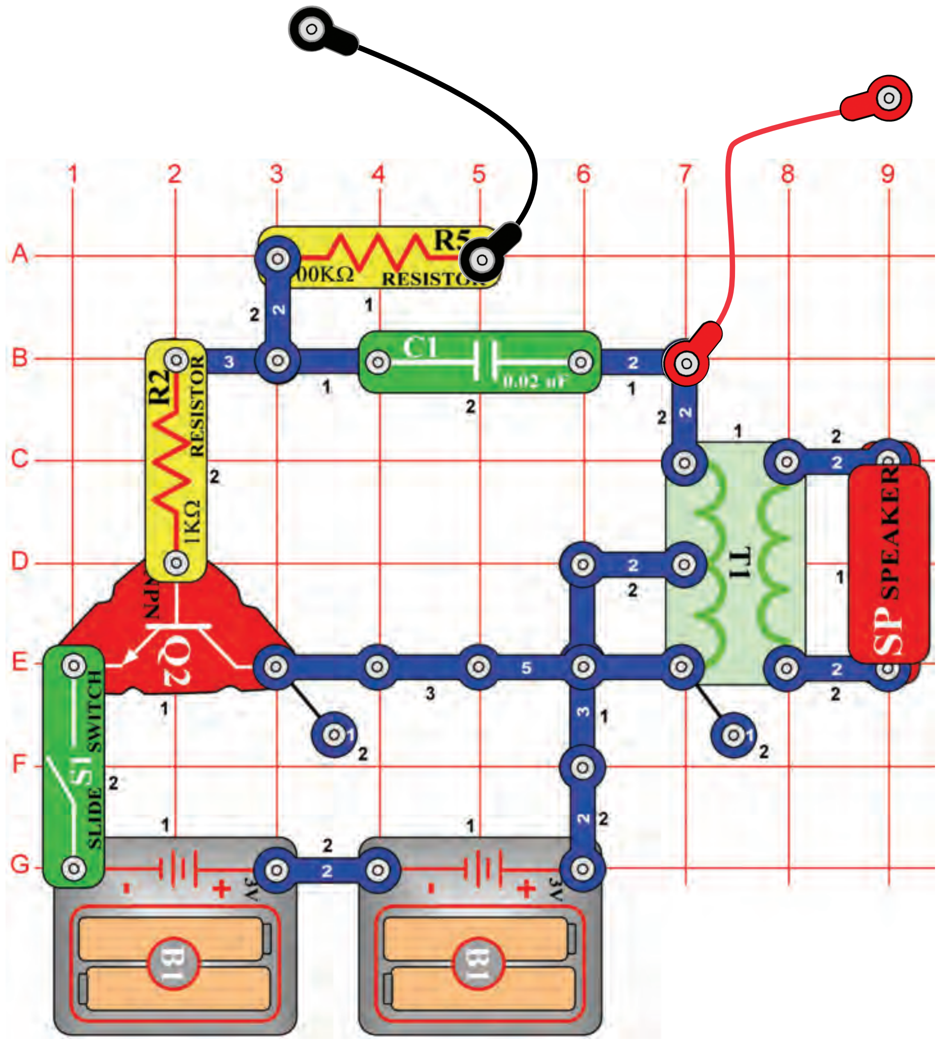
This circuit was suggested by Luke S. of Westborough, MA.

To learn more about how circuits work, visit www.snapcircuits.net or page 85 to find out about our Student Guides.

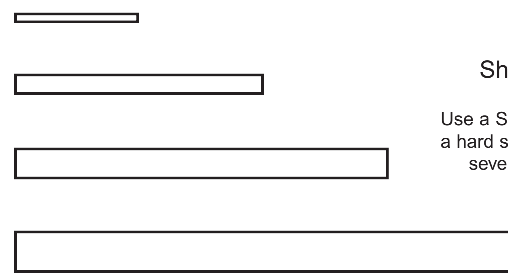
Project #516

Drawing Resistors

OBJECTIVE: To make your own resistors.



You need some more parts to do this experiment, so you're going to draw them. Take a pencil (No. 2 lead is best but other types will also work), **SHARPEN IT**, and fill in the 4 rectangles you see below. You will get better results if you **place a hard, flat surface between this page and the rest of this booklet** while you are drawing. **Press hard** (but don't rip the paper) and **fill in each several times** to be sure you have a **thick, even layer of pencil** lead and try to avoid going out of the boundaries.



Shapes to be drawn.

Use a SHARP No. 2 pencil, draw on a hard surface, press hard and fill in several times for best results.

Actually, your pencils aren't made out of lead anymore (although we still call them "lead pencils"). The "lead" in your pencils is really a form of carbon, the same material that resistors are made of. So the drawings you just made should act just like the resistors in Snap Circuits®.

Build the circuit shown, it is the same basic oscillator circuit you have been using. Touch the the loose ends of the jumper wires to opposite ends of the rectangles you drew, you should hear a sound like an alarm. **Note:** You may get better electrical contact between the wires and the drawings if you wet the metal with a few drops of water or saliva.

Making the drawn resistors longer should increase the resistance while making them wider should reduce the resistance. So all 4 rectangles should produce the same sound, though you will see variations due to how thick and evenly you filled in the rectangles, and exactly where you touch the wires. If your 4 shapes don't sound similar then try improving your drawings.

Be sure to wash your hands after this project.

Project #517 Electronic Kazoo

Use the same circuit as project #516, but draw a new shape. A Kazoo is a musical instrument that is like a one-note flute, and you change the pitch (frequency) of the sound by moving a plunger up and down inside a tube.

As before, take a pencil (No. 2 lead is best but other types will also work), **SHARPEN IT** again, and fill in the shape you see below. For best results, **SHARPEN IT again**, **place a hard flat surface between this page and the rest of this booklet** while you are drawing. **Press hard** (but don't rip the paper). **Fill in each several times** to be sure you have a **thick, even layer of pencil** lead, and try to avoid going out of the boundaries. **Where the shape is just a line, draw a thick line and go over it several times.** The black ink in this manual is an insulator just like paper, so you have to write over it with your pencil.

Take one loose wire and touch it to the widest part of this shape, at the upper left. Take the other loose wire and touch it just to the right of the first wire. You should hear a high-pitch sound. How do you think the sound will change as you slide the second wire to the right? Do it, slowly sliding all the way around to the end. The sound changes from high frequency to low frequency, just like a kazoo. **Note:** You may get better electrical contact between the wires and the drawings if you wet the wires with a few drops of water or saliva.

Shape to be drawn.

Use a SHARP No. 2 pencil, draw on a hard surface, press hard and fill in several times for best results.

Project #518 Electronic Kazoo (II)

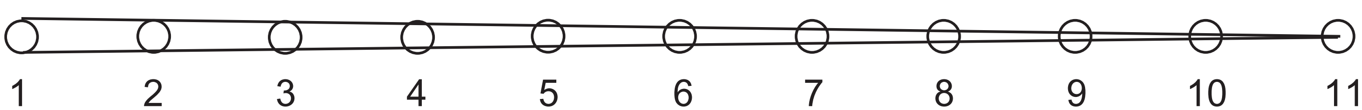
Use the same circuit as project #516, but fill in the new shape shown here.

Take one loose jumper wire and touch it to the left circle. Take the other loose wire and touch it to each of the other circles. The various circles produce different pitches in the sound, like notes. Since the circles are like keys on a piano, you now have an electronic keyboard! See what kind of music you can play with it. **Note:** You may get better electrical contact between the wires and the drawings if you wet the wires with a few drops of water or saliva.

Now take one loose wire and touch it to the right circle (#11). Take the other wire and touch it to the circles next to the numbers shown below, in order:

7 - 5 - 1 - 5 - 7 - 7 - 7
5 - 5 - 5
7 - 7 - 7
7 - 5 - 1 - 5 - 7 - 7 - 7 - 7 - 5 - 5 - 7 - 5 - 1

Do you recognize this nursery rhyme? It is "Mary Had a Little Lamb". By now you see that you can draw any shape you like and make electronic sounds with it. Experiment on your own as much as you like. Be sure to wash your hands after this test.



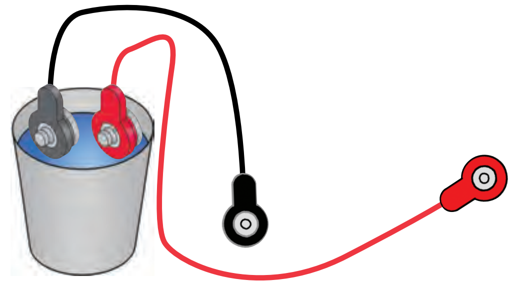
Shape to be drawn.

Use a SHARP No. 2 pencil, draw on a hard surface, press hard and fill in several times for best results.

Project #519

Water Resistor

OBJECTIVE: To use water as a resistor.



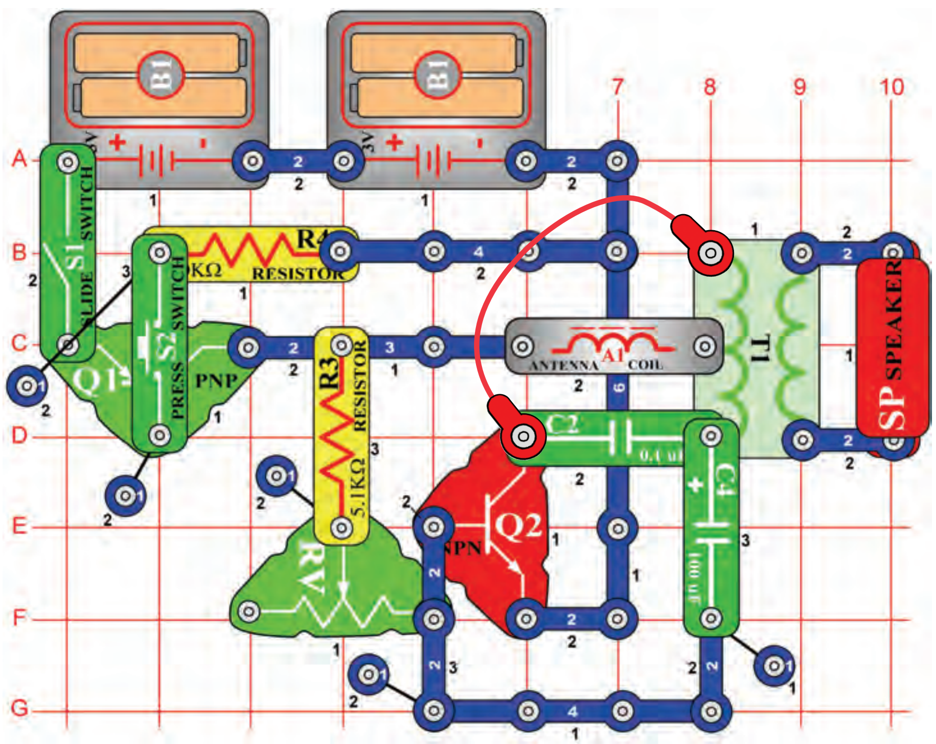
Use the same circuit as project #516. Take the two loose jumper wires and touch them with your fingers. You should hear a low-frequency sound. Now place the loose jumpers in a cup of water without them touching each other. The sound will have a much higher frequency because drinking water has lower resistance than your body. You can change the sound by adding or removing water from the cup. If you add salt to the water then you will notice the frequency increase, because dissolving salt lowers the resistance of the water.

You can also make a water kazoo. Pour a small amount of water on a table or the floor and spread it with your finger into a long line. Place one of the jumper wires at one end and slide the other along the water. You should get an effect just like the kazoo you drew with the pencil, though the frequency will probably be different.

Project #520

Two-Transistor Oscillator

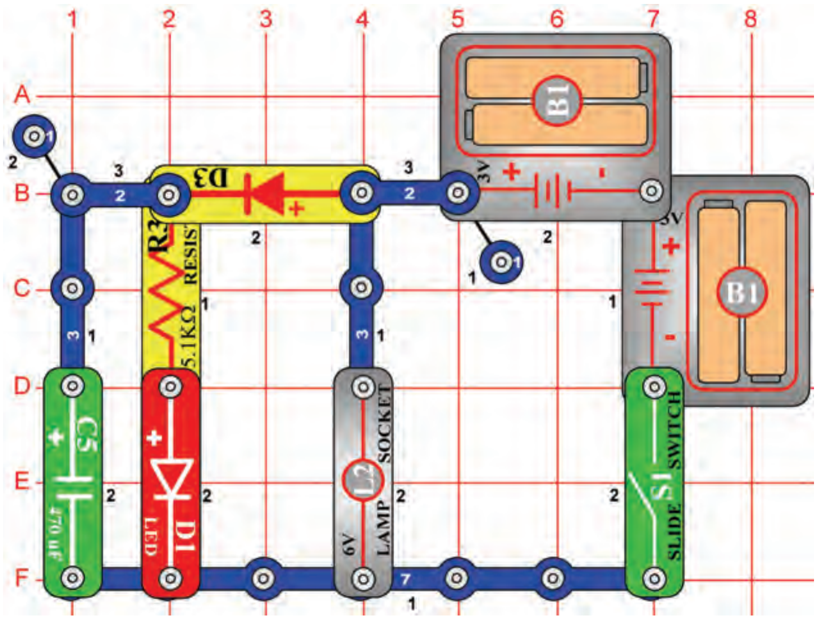
OBJECTIVE: To make an adjustable low-frequency oscillator.



Build the circuit, turn on the slide switch (S1), and then press the press switch (S2). Move the control lever of the adjustable resistor (RV) to change the frequency.

Project #521 Diode

OBJECTIVE: To show how a diode works.

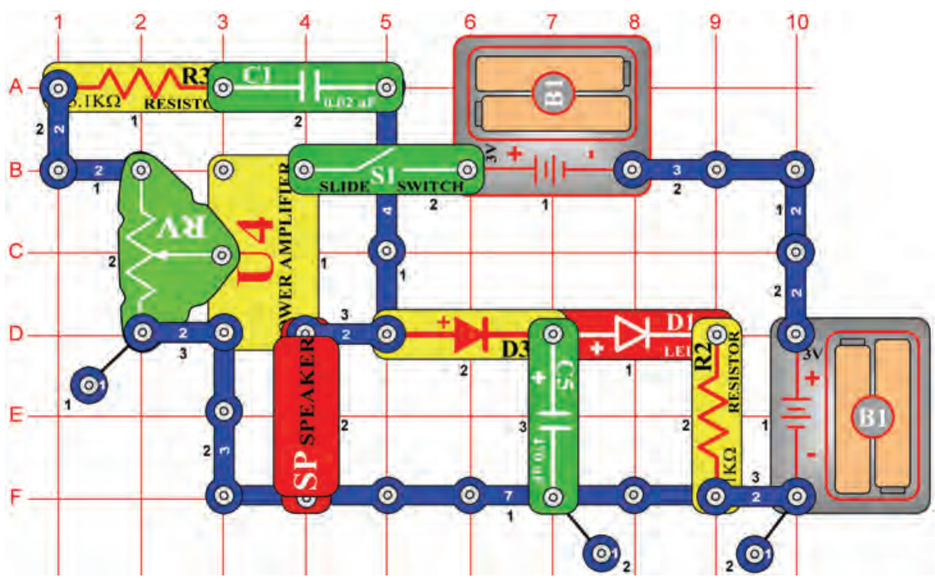


Turn on the slide switch (S1), the lamp (L2) will be bright and the LED (D1) will be lit. The diode (D3) allows the batteries to charge up the 470μF capacitor (C5) and light the LED.

Turn off the slide switch, the lamp will go dark immediately but the LED will stay lit for a few seconds as capacitor C5 discharges through it. The diode isolates the capacitor from the lamp; if you replace the diode with a 3-snap wire then the lamp will drain the capacitor almost instantly.

Project #522 Rectifier

OBJECTIVE: To build a rectifier.



This circuit is based on the Trombone project #238. Turn on the slide switch (S1) and set the adjustable resistor (RV) for mid-range for the best sound. The LED (D1) will also be lit.

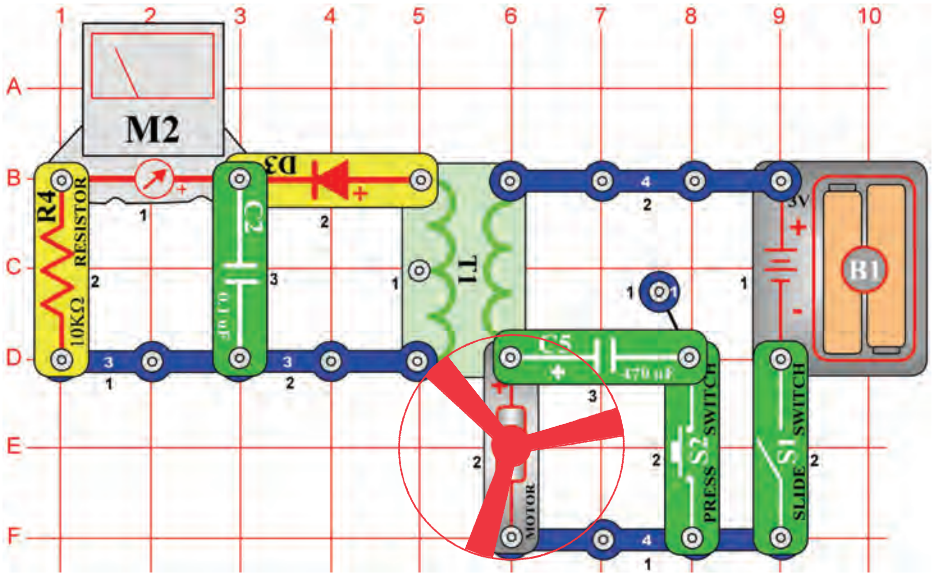
The signal from the power amplifier (U4) to the speaker (SP) is a changing (AC) voltage, not the constant (DC) voltage needed to light the LED. The diode (D3) and capacitor (C5) are a rectifier, which converts the AC voltage into a DC voltage.

The diode allows the capacitor to charge up when the power amp voltage is high, but also prevents the capacitor from discharging when the power amp voltage is low. If you replace the diode with a 3-snap or remove the capacitor from the circuit, the LED will not light.

☐ Project #523

Motor Rectifier

OBJECTIVE: To show how what a rectifier does.



Set the meter (M2) to the LOW (or 10mA) scale. Place the fan on the motor (M1) and turn on the slide switch (S1), the meter measures the current on the other side of the transformer (T1).

As the DC voltage from the battery (B1) spins the motor, the motor creates an AC ripple in the voltage. This ripple passes through the transformer using magnetism. The diode and 0.1μF capacitor (C2) “rectify” the AC ripple into the DC current that the meter measures.

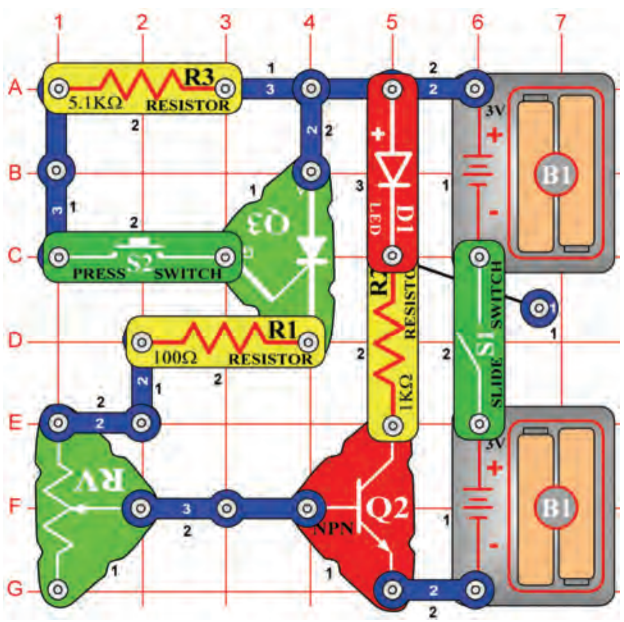
Holding down the press switch (S2) connects the 470μF capacitor (C5) across the motor. This filters out the AC ripple, so the current through the meter is greatly reduced but the motor speed is not affected.

WARNING: Moving parts. Do not touch the fan or motor during operation. Do not lean over the motor.

☐ Project #524

SCR Shutdown

OBJECTIVE: To show how an SCR works.



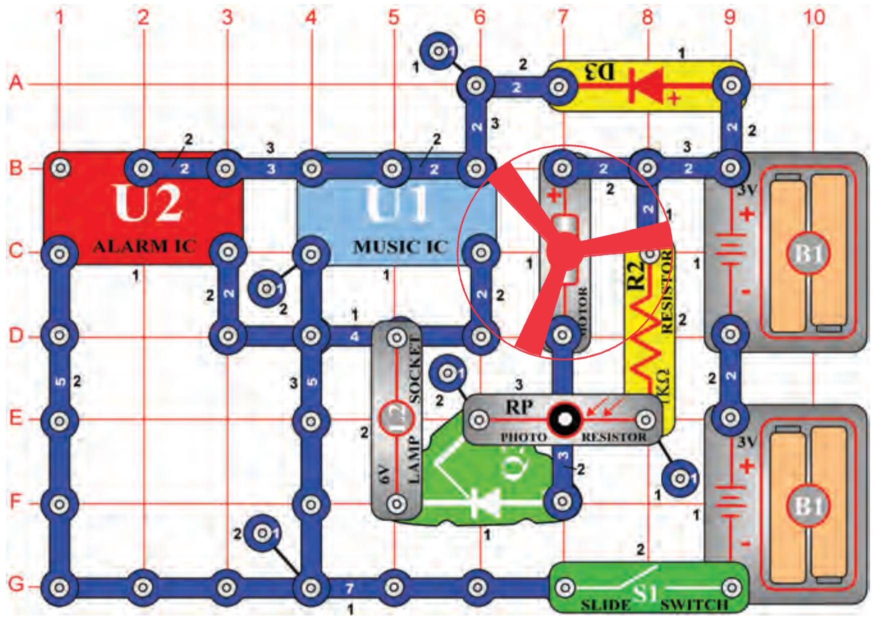
In this circuit the press switch (S2) controls an SCR (Q3), which controls a transistor (Q2), which controls an LED (D1). Set the adjustable resistor (RV) control lever to the top (toward the press switch).

Turn on the slide switch (S1); nothing happens. Press and release the press switch; the SCR, transistor, and LED turn on and stay on. Now move the adjustable resistor control down until the LED turns off. Press and release the press switch again; this time the LED comes on but goes off after you release the press switch.

If the current through an SCR (anode-to-cathode) is above a threshold level, then the SCR stays on. In this circuit you can set the adjustable resistor so that the SCR (and the LED it controls) just barely stays on or shuts off.

Project #525 SCR Motor Control

OBJECTIVE: To show how an SCR is used.



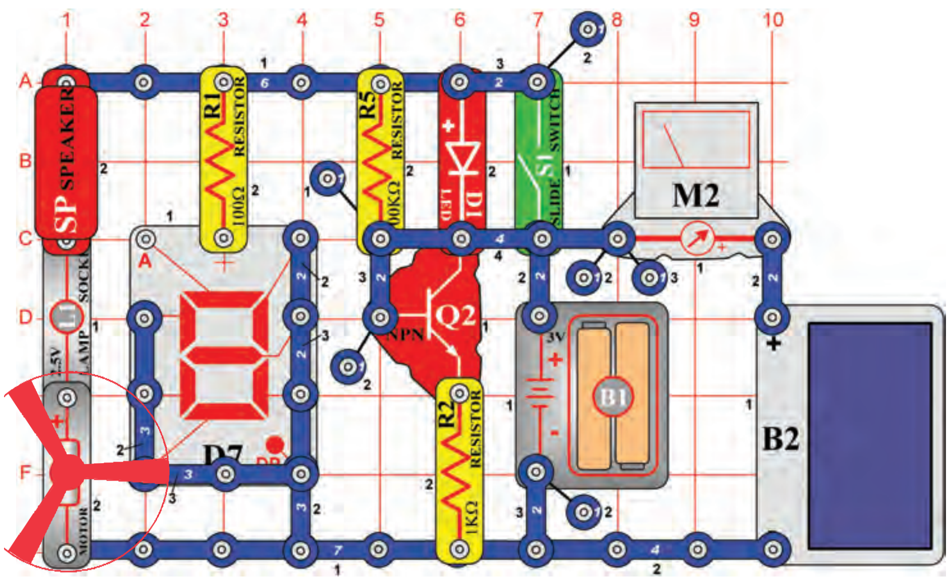
SCR's are often used to control the speed of a motor. The voltage to the gate would be a stream of pulses, and the pulses are made wider to increase the motor speed.

Place the fan on the motor (M1) and turn on the slide switch (S1). The motor spins and the lamp (L2) lights. Wave your hand over the photoresistor (RP) to control how much light shines on it, this will adjust the speed of the motor. By moving your hand in a repetitive motion, you should be able spin the motor at a slow and steady speed.

WARNING: Moving parts. Do not touch the fan or motor during operation. Do not lean over the motor.

Project #526 Output Forms

OBJECTIVE: To show the different types of output from Snap Circuits®.



Set the meter (M2) to the LOW (or 10mA) scale. This circuit uses all six forms of output available in Snap Circuits® - speaker (SP, sound), lamp (L1, light), LED (D1, light), motor (M1, motion), 7-segment display (D7, light), and meter (M2, motion of pointer).

Place the fan on the motor, turn on the slide switch (S1), and shine light on the solar cell (B2). There will be activity from all six forms of output. If the motor does not spin, then give it a push with your finger to start it, or remove the fan.

WARNING: Moving parts. Do not touch the fan or motor during operation. Do not lean over the motor.

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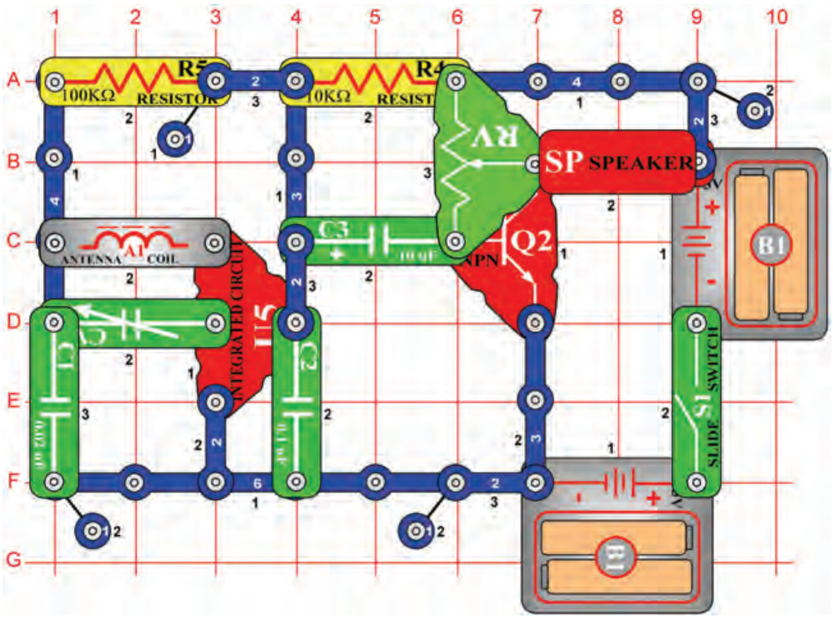
Project #527 Transistor AM Radio

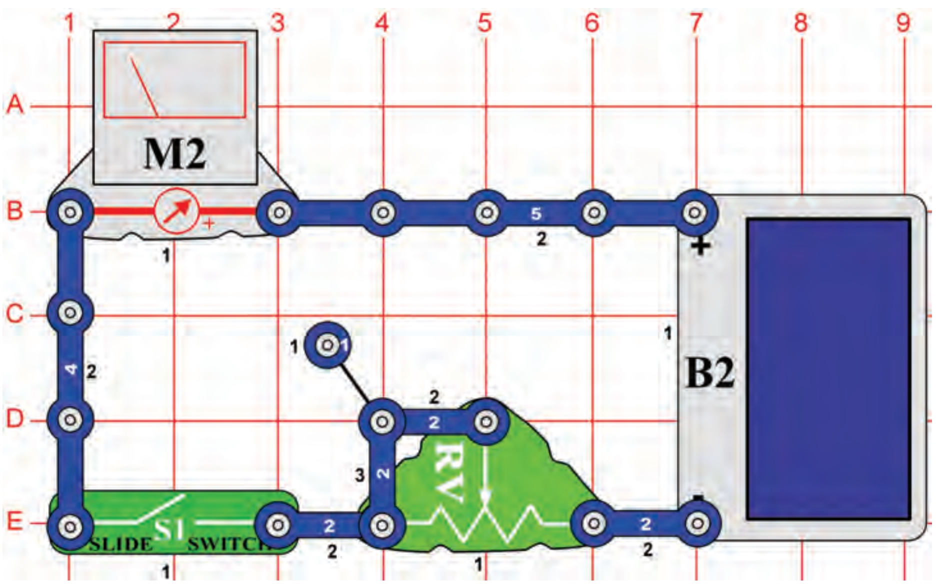
OBJECTIVE: To show the output of an AM radio.



This AM radio circuit uses a transistor (Q2) in the amplifier that drives the speaker (SP). Turn on the slide switch (S1) and adjust the variable capacitor (CV) for a radio station, then adjust the loudness using the adjustable resistor (RV).

Project #528 Adjustable Solar Power Meter

OBJECTIVE: To learn about solar power.



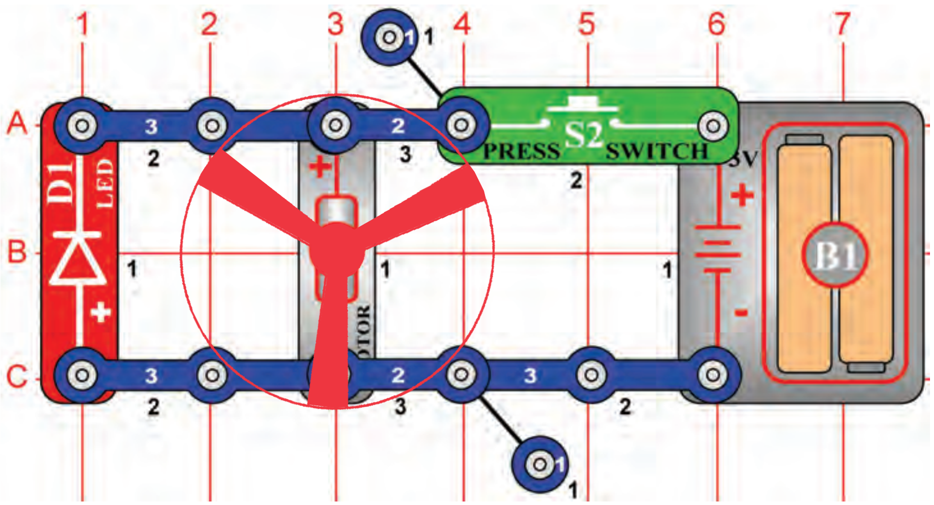
Set the adjustable resistor (RV) for mid-range and the meter (M2) for the LOW (or 10mA) setting. Turn on the slide switch (S1) and let light shine on the solar cell (B2). Move the solar cell around different light sources and adjust the adjustable resistor to change the reading on the meter.

Place your hand to cover half of the solar cell, the meter reading should drop by half. When you reduce the light to the solar cell, the current in the circuit is reduced.

Place a sheet of paper over the solar cell and see how much it changes the reading on the meter. Then add more sheets until the meter reads zero.

Project #529 Fan Blade Storing Energy

OBJECTIVE: To show that the fan blade stores energy.



Place the fan on the motor (M1). Hold down the press switch (S2) for a few seconds and then watch the LED (D1) as you release the press switch. The LED lights briefly but only after the batteries (B1) are disconnected from the circuit.

Do you know why the LED lights? It lights because the mechanical energy stored in the fan blade makes the motor act like a generator. When the press switch is released, this energy creates a brief current through the LED. If you remove the fan blade from the circuit then the LED will never light, because the motor shaft alone does not store enough mechanical energy.

If you reverse the motor direction, then the LED will light the same way, but the fan may fly off after the LED lights.

WARNING: Moving parts. Do not touch the fan or motor during operation. Do not lean over the motor.

This circuit was suggested by Mike D. of Woodhaven, NY.

Project #530 Antenna Storing Energy

OBJECTIVE: To show that the antenna stores energy.

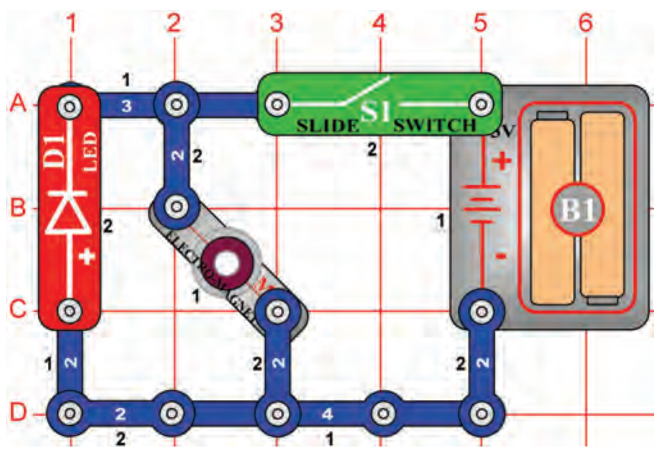
Modify project #529 by replacing the motor (M1) with the antenna coil (A1). Hold down the press switch (S2) and then watch the LED (D1) as you release the press switch. The LED lights briefly but only after the batteries (B2) are disconnected from the circuit.

This circuit is different from the Fan Blade Storing Energy project because energy in the antenna coil is stored in a magnetic field. When the press switch is released, this field creates a brief current through the LED.

Note that the energy stored in a magnetic field acts like mechanical momentum, unlike capacitors which store energy as an electrical charge across a material. You can replace the antenna with any of the capacitors but the LED will not light. Energy stored in the magnetic fields of coils was called electrical momentum in the early days of electronics.

Project #531 Electromagnet Storing Energy

OBJECTIVE: To show that the electromagnet stores energy.

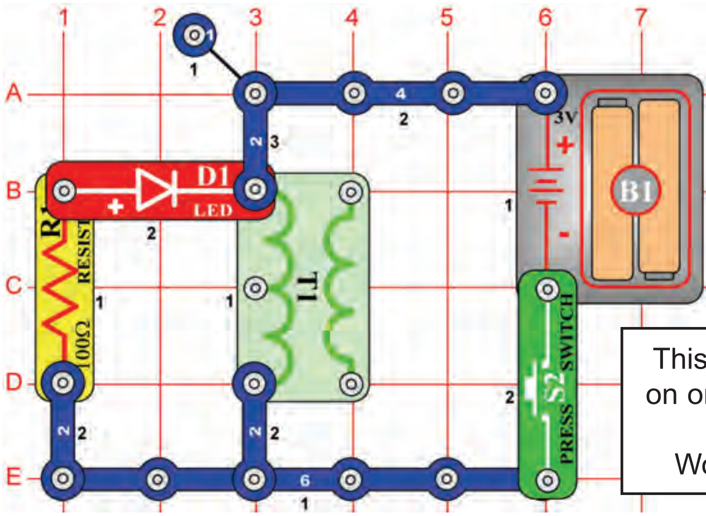


Turn on the slide switch (S1); nothing happens. Turn the switch off; the LED (D1) flashes.

When you turn on the switch, the electromagnet (M3) stores energy from the batteries (B1) into a magnetic field. When you turn off the switch, the magnetic field collapses and the energy from it discharges through the LED.

Project #532 Transformer Storing Energy

OBJECTIVE: To show that the transformer stores electrical energy.



This circuit is based on one suggested by Mike D. of Woodhaven, NY.

Hold down the press switch (S2) and then watch the LED (D1) as you release the press switch. The LED lights briefly but only after the batteries (B1) are disconnected from the circuit.

This circuit is similar to the Antenna Storing Energy project, and shows how the coils in the transformer (T1) also store energy in magnetic fields. When the press switch is released, this energy creates a brief current through the LED.

Project #533 Relay Storing Energy

OBJECTIVE: To show that the relay stores energy.

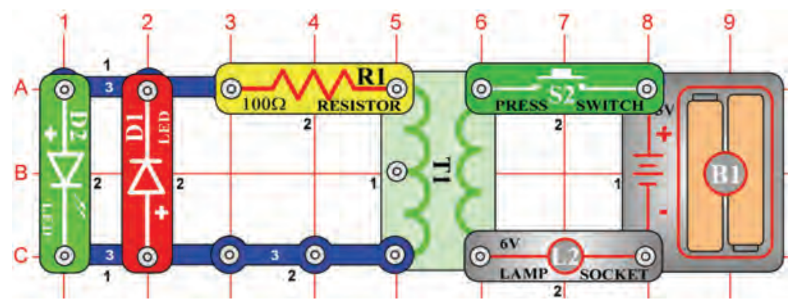
Modify project #532 by replacing the transformer (T1) with the relay (S3), position it with the 3-snap sides to top and right (as in project #341).

Hold down the press switch (S2) and then watch the LED (D1) as you release the press switch. The LED lights briefly but only after the batteries (B1) are disconnected from the circuit.

The relay has a coil similar to the one in the transformer, and stores energy in the same way.

Project #534 Transformer Lights

OBJECTIVE: To show how the transformer works.



Watch the LED's (D1 & D2) as you press or release the press switch (S2). The red LED (D1) lights briefly just as you press the press switch and the green LED (D2) lights briefly just after you release it, but neither lights while you hold the press switch down. Why?

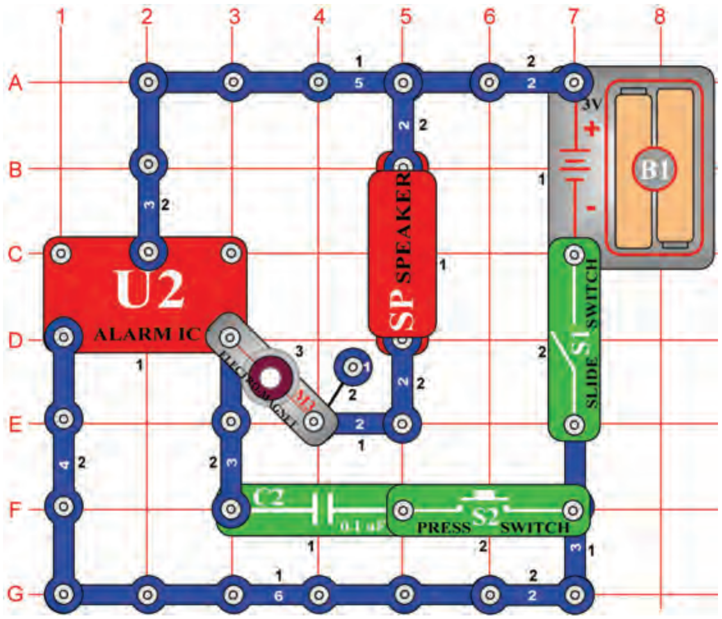
When you press the press switch, a surge of current from the battery charges a magnetic field in the transformer (T1), which stays constant as the press switch is held down. Charging the magnetic field induces an opposing current on the other side of the transformer, which lights the red LED until the magnetic fields stabilize.

When you release the press switch (removing the current from the battery), the magnetic field discharges. Initially the transformer tries to maintain the magnetic field by inducing a current on the other side, which lights the green LED until the resistor (R1) absorbs the remaining energy.

Note that this project is different from the Antenna Storing Energy project because there is a magnetic connection across the transformer, not an electrical connection.

☐ Project #535 Machine Siren

OBJECTIVE: To see how the electromagnet can change the sound from the alarm IC.

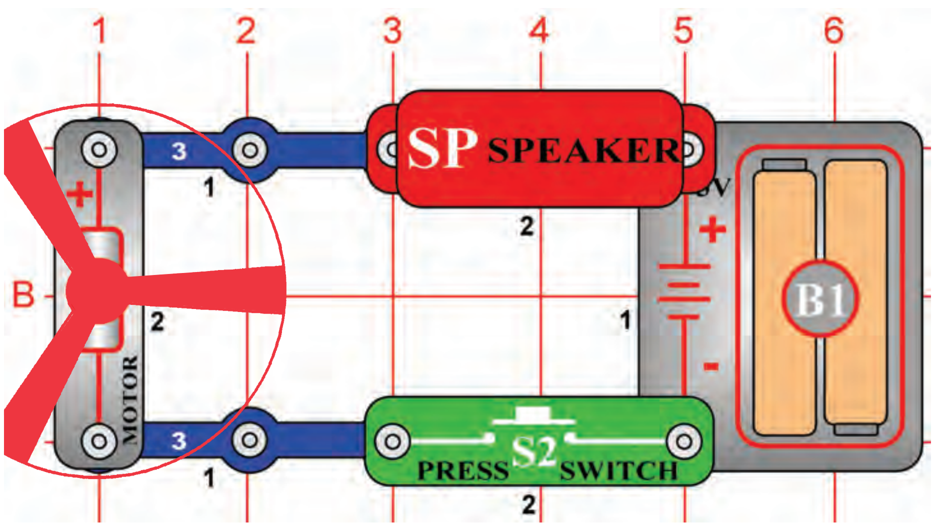


Turn on the slide switch (S1), you hear a strange sound from the speaker (SP). Push the press switch (S2) and the sound changes to a high-pitch siren.

The alarm IC (U2) produces a smooth siren sound, but the electromagnet (M3) distorts the siren into the strange sound you hear. Adding the 0.1μF capacitor (C2) counters the electromagnet effects and restores the siren.

☐ Project #536 Hear the Motor

OBJECTIVE: To show how a motor works.



WARNING: Moving parts. Do not touch the fan or motor during operation. Do not lean over the motor.

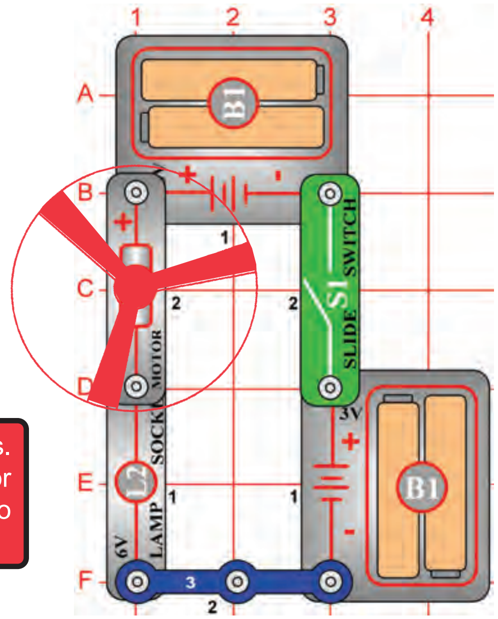
Place the fan on the motor (M1). Press the press switch (S2) and listen to the motor. Why does the motor make sound?

A motor uses magnetism to convert electrical energy into mechanical spinning motion. As the motor shaft spins around it connects/disconnects several sets of electrical contacts to give the best magnetic properties. As these contacts are switched, an electrical disturbance is created, which the speaker converts into sound.

This circuit was suggested by Andrew M. of Cochrane, Alberta, Canada

Project #537 — Back EMF

OBJECTIVE: To demonstrate how the motor works.



The voltage produced by a motor when it is spinning is called its *Back Electro-Motive-Force* (Back EMF); this may be thought of as the motor's electrical resistance. The motor's *Front Electro-Motive-Force* is the force it exerts in trying to spin the shaft. This circuit demonstrates how the Back EMF increases and the current decreases as the motor speeds up.

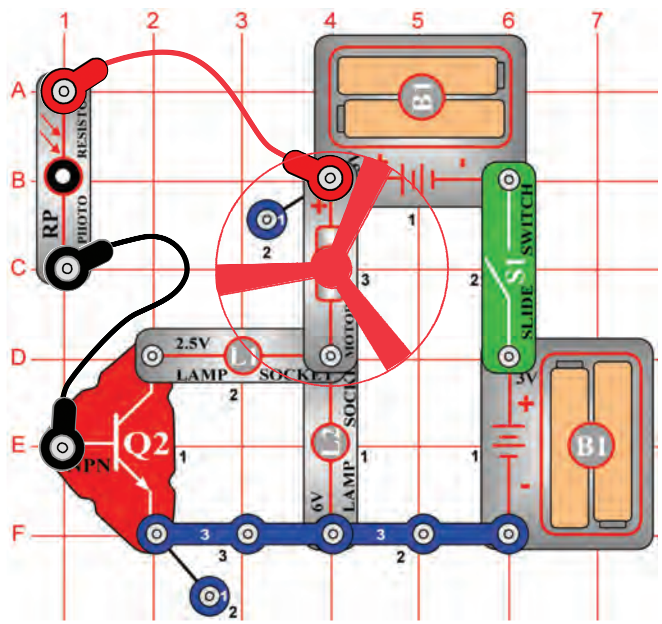
Place the fan on the motor (M1) and turn on the slide switch (S1). The 6V bulb (L2) will be bright, indicating that the Back EMF is low and the current is high.

Turn off the slide switch, remove the fan, and turn the slide switch back on. The lamp is bright when the motor starts and the lamp dims as the motor speeds up. Now the Back EMF is high and the current is low. BE CAREFUL NOT TO TOUCH THE MOTOR WHILE IT SPINS.

WARNING: Moving parts. Do not touch the fan or motor during operation. Do not lean over the motor.

Project #538 — Back EMF (II)

OBJECTIVE: To demonstrate how the motor draws more current to exert greater force when spinning slowly.



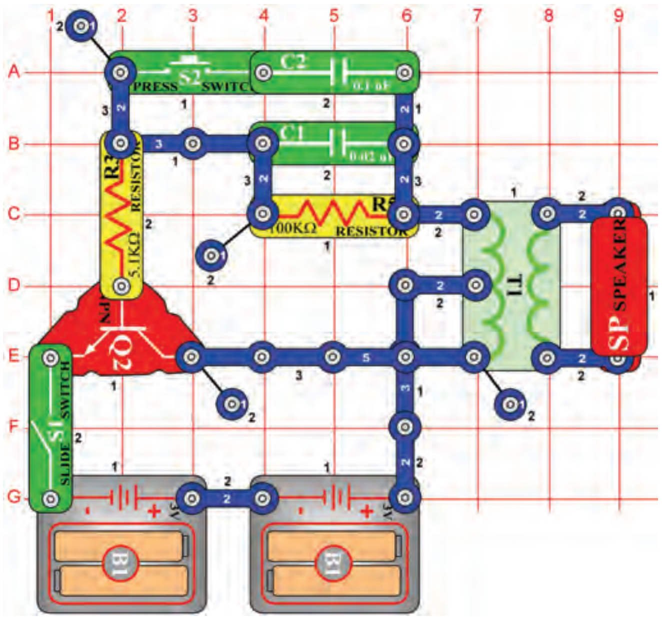
Place the fan on the motor (M1). Connect the photoresistor (RP) with the jumper wires as shown, and hold it next to the 6V lamp (L2) so the light shines on it.

Turn on the slide switch (S1) and watch how the 6V lamp is bright at first, but gets dim as the motor speeds up. By moving the photoresistor (RP) next to or away from the 6V lamp, you should be able to change the motor speed. To slow the motor down even more, cover the photoresistor.

When the photoresistor is held next to the 6V lamp, transistor Q2 (with lamp L1) will try to keep the motor at a constant speed.

WARNING: Moving parts. Do not touch the fan or motor during operation. Do not lean over the motor.

Project #539 Electronic Sound



OBJECTIVE: To make different tones with an oscillator.

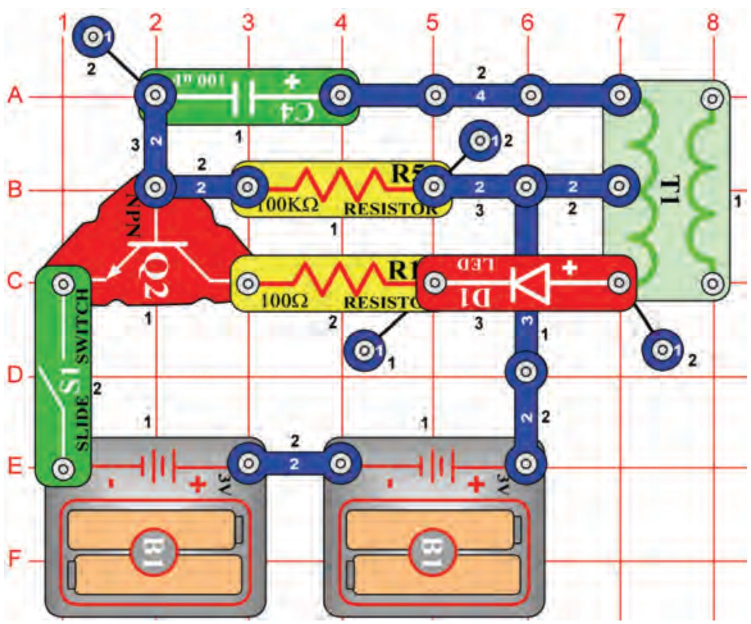
Build the circuit and turn on the slide switch (S1), you hear a high-frequency tone. Press the press switch (S2) to lower the frequency by increasing the capacitance in the oscillator. Replace the 0.1μF capacitor (C2) with the 10μF capacitor (C3, "+" on the right) to further lower the frequency of the tone.

Project #540 Electronic Sound (II)

OBJECTIVE: To make different tones with an oscillator.

You can also change the frequency by changing the resistance in the oscillator. Replace the 100KΩ resistor (R5) with the 10KΩ resistor (R4), place the 0.1μF capacitor (C2) back in the circuit as before.

Project #541 Lighthouse



OBJECTIVE: To make a blinking light.

Build the circuit and turn on the slide switch (S1), the LED (D1) flashes about once a second.

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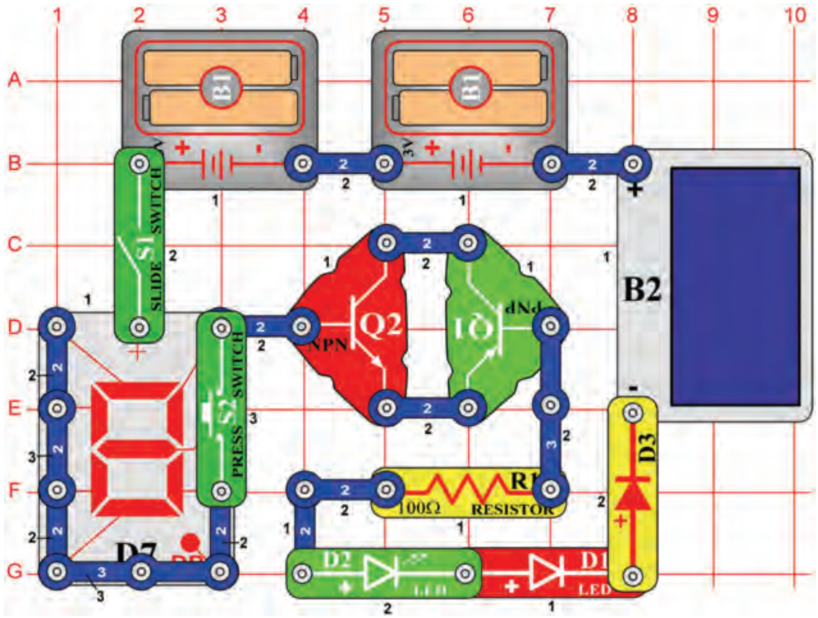
☐ Project #542 — Diode Wonderland

OBJECTIVE: To learn more about diodes.



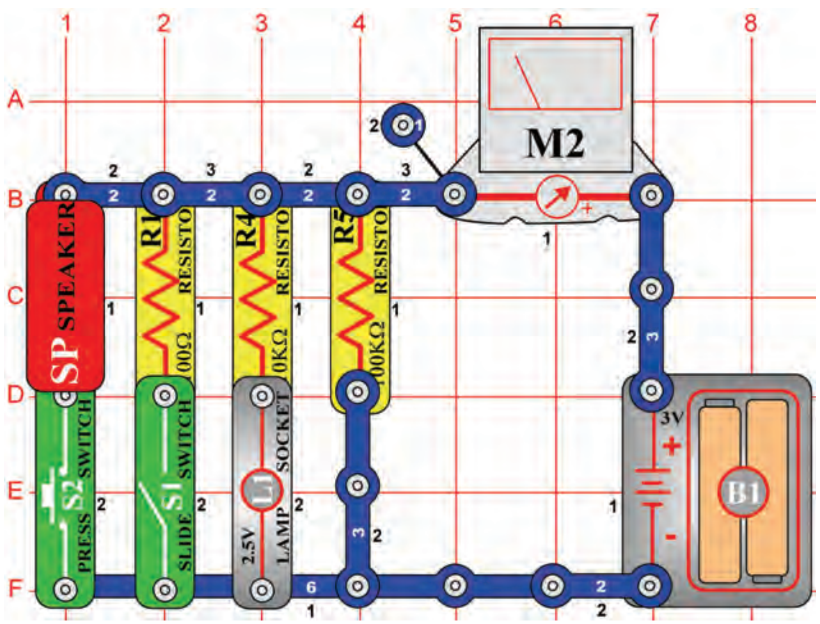
Cover the solar cell (B2) and turn on the slide switch (S1), there should be little or no light from the LED's (results depend on your batteries). Shine a bright light on the solar cell and the red (D1) and green (D2) LED's should be bright, along with one segment of the 7-segment display (D7).

This circuit shows how it takes a lot of voltage to turn on a bunch of diodes connected in a series. Since the transistors (Q1 & Q2) are used as diodes here, there are six diodes total (D1, D2, D3, D7, Q1, and Q2). The voltage from the batteries (B1) alone is not enough to turn them all on at the same time, but the extra voltage produced by the solar cell is enough to make them bright.

Now push the press switch (S2) and D7 will display "0.", but it will be dim unless the light on the solar cell is very bright. With S2 off, all the current through D7 goes through segment B and makes it bright. With S2 on, the current through D7 divides evenly between several segments.

☐ Project #543 — Meter Ranges

OBJECTIVE: To show the difference between the low and high current meter ranges.



Use the LOW (or 10mA) setting on the meter (M2), turn off the slide switch (S1), and unscrew the 2.5V bulb (L1). The meter should measure about 2, since the 100KΩ resistor (R5) keeps the current low. Results will vary depending on how good your batteries are.

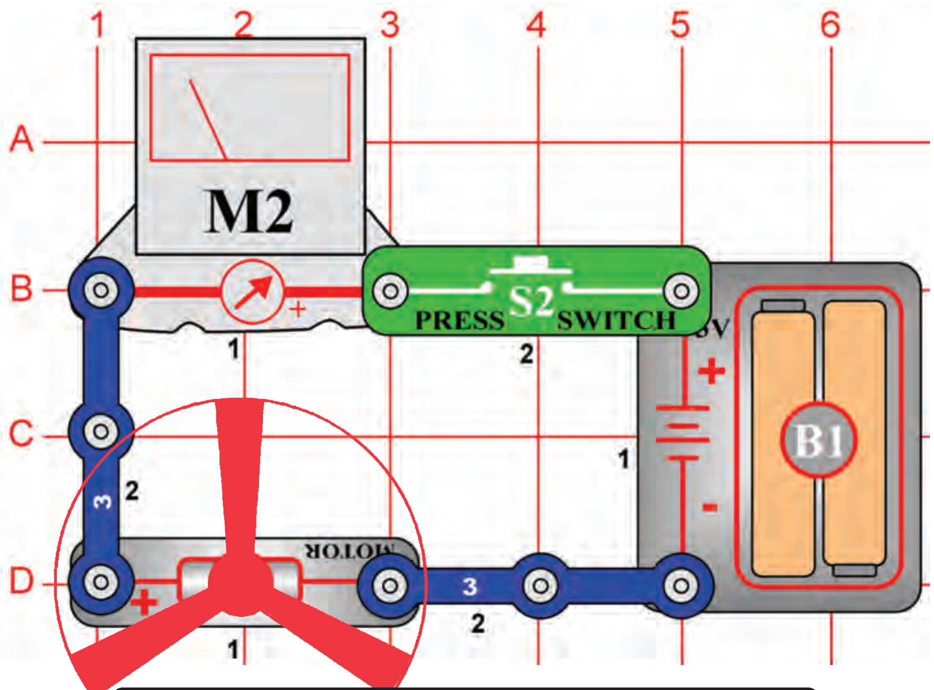
Screw in the 2.5V bulb to add the 10KΩ resistor (R4) to the circuit, now the meter reading will be about 10.

Change the meter to the high-current HIGH (or 1A) setting. Now turn on the slide switch to add the 100Ω resistor to the circuit. The meter should read just above zero.

Now press the switch (S2) to add the speaker (SP) to the circuit. The meter reading will be about 5, since the speaker has only about 8Ω resistance.

Project #544 Motor Current

OBJECTIVE: To measure the motor current.



WARNING: Moving parts. Do not touch the fan or motor during operation. Do not lean over the motor.

Use the HIGH (or 1A) setting on the meter (M2) and place the fan on the motor (M1). Press the press switch (S2), the meter will measure a very high current because it takes a lot of power to spin the fan.

Remove the fan and press the press switch again. The meter reading will be lower since spinning the motor without the fan takes less power.

Project #545 2.5V Lamp Current

OBJECTIVE: To measure the 2.5V lamp current.

Use the circuit from project #544, but replace the motor with the 2.5V lamp (L1). Measure the current using the HIGH (or 1A) setting on the meter.

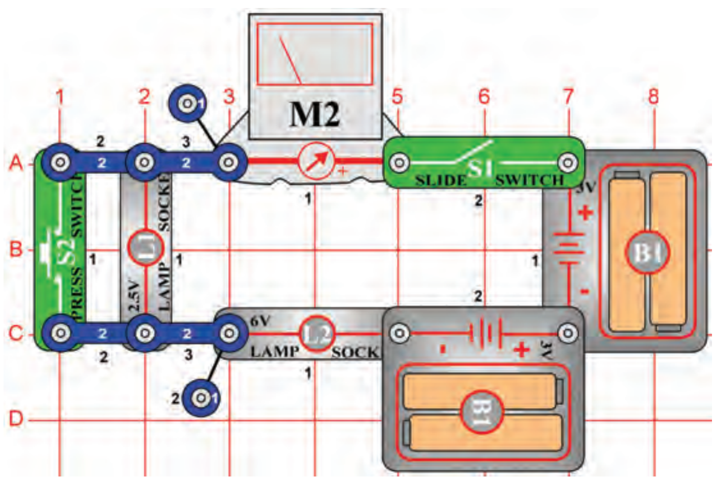
Project #546 6V Lamp Current

OBJECTIVE: To measure the 6V lamp current.

Use the circuit from project #544 but replace the motor with the 6V lamp (L2). Measure the current using the HIGH (or 1A) setting on the meter (M2). Compare the lamp brightness and meter reading to that for the 2.5V lamp (L1).

Project #547 Combined Lamp Circuits

OBJECTIVE: To measure current through the lamps.

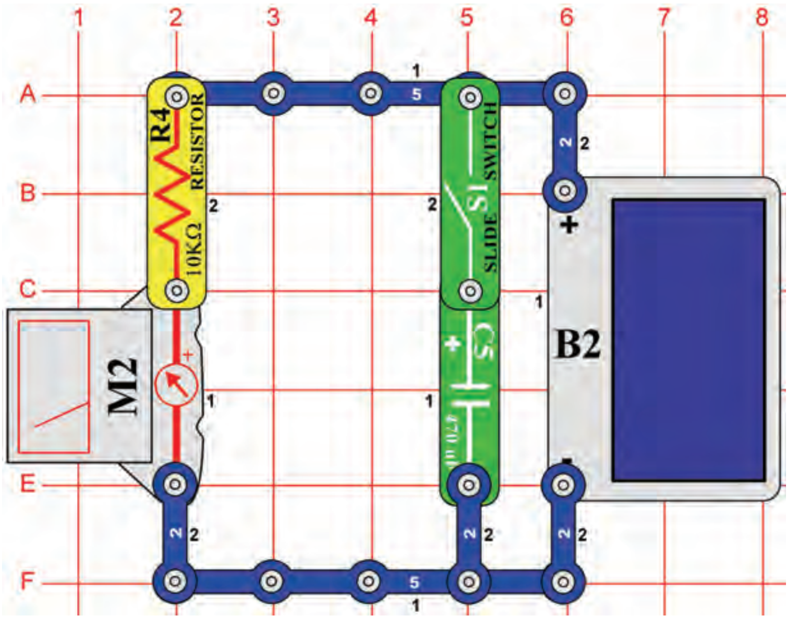


Use the HIGH (or 1A) setting on the meter (M2) and turn on the slide switch (S1). Both lamps are on and the meter measures the current.

Now turn on the press switch (S2) to bypass the 2.5V lamp (L1). The 6V lamp (L2) is brighter now, and the meter measures a higher current.

Project #548 Rechargeable Battery

OBJECTIVE: To show how a capacitor is like a rechargeable battery.

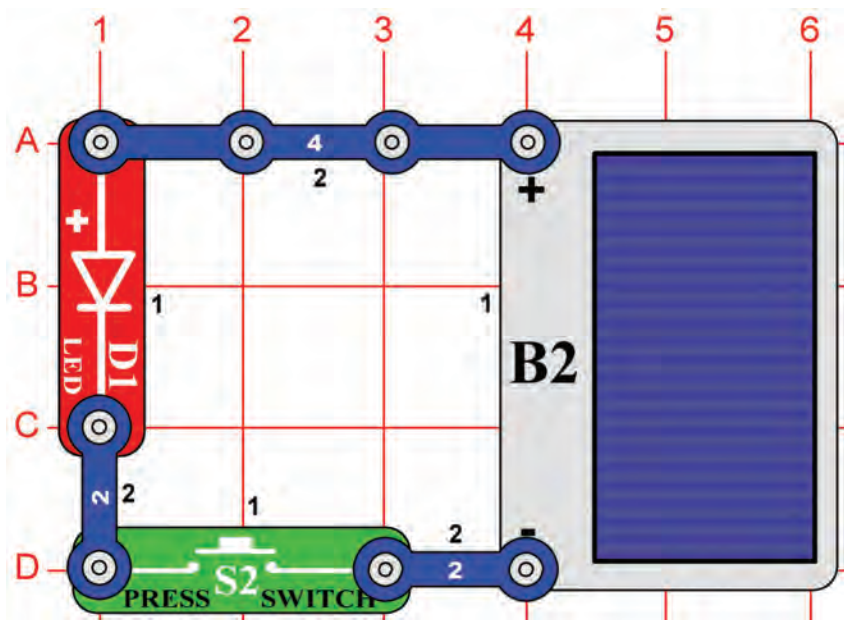


Use the LOW (or 10mA) scale on the meter (M2) and turn the slide switch (S1) off. Vary the current measured on the meter by moving your hand over the solar cell (B2) to block some of the light to it. If you cover the solar cell, then the current immediately drops to zero.

Now turn the slide switch on and watch the meter again as you move your hand over the solar cell. Now the meter current drops slowly if you block the light to the solar cell. The 470μF capacitor (C5) is acting like a rechargeable battery. It keeps a current flowing to the meter when something (such as clouds) blocks light to the solar cell that is powering the circuit.

Project #549 Solar Batteries

OBJECTIVE: To learn about solar power.



Place this circuit near different types of lights and press the press switch (S2). If the light is bright enough, then the LED (D1) will be lit. Find out what types of light sources make it the brightest.

Solar cells work best with bright sunlight, but incandescent light bulbs (used in house lamps) also work well. Fluorescent lights (the overhead lights in offices and schools) do not work as well with solar cells. Although the voltage produced by your solar cell is 3V just like the batteries, it cannot supply nearly as much current. If you replace the LED with the 2.5V lamp (L1) then it will not light, because the lamp needs a much higher current.

The solar cell (B2) is made from silicon crystals. It uses the energy in sunlight to make an electric current. Solar cells produce electricity that will last as long as the sun is bright. They are pollution-free and never wear out.

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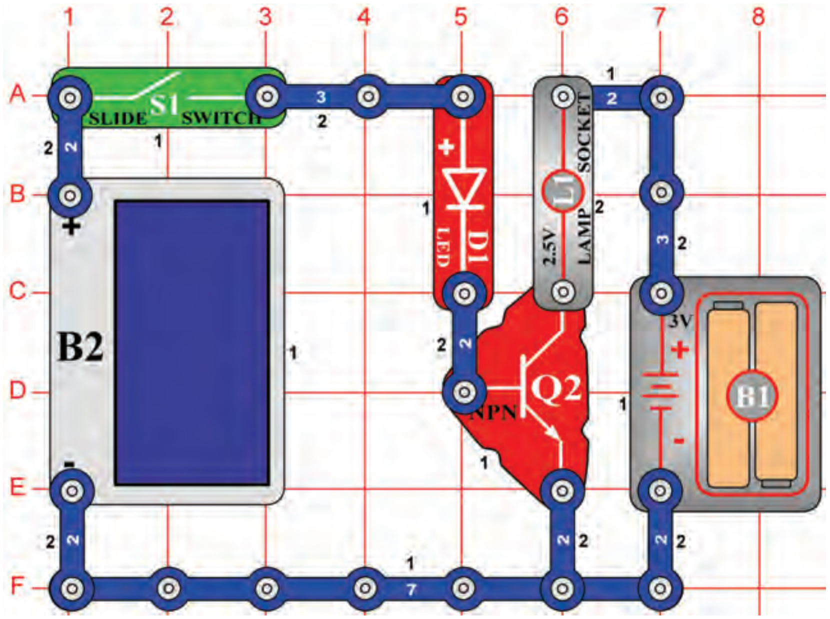
Project #550 — Solar Control



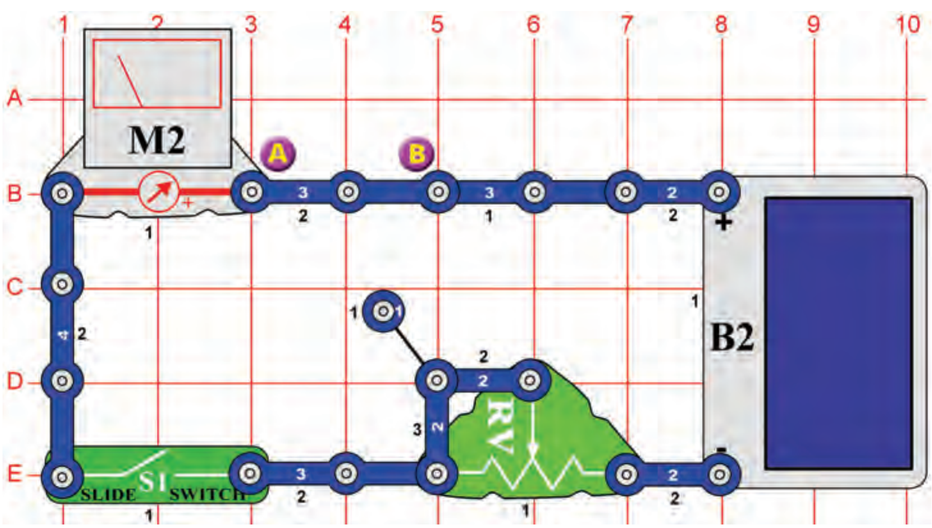
OBJECTIVE: To learn about solar power.

Build the circuit and turn on the slide switch (S1). If there is sunlight on the solar cell (B2), then the LED (D1) and lamp (L1) will be on.

This circuit uses the solar cell to light the LED and to control the lamp. The solar cell does not produce enough power to run the lamp directly. You can replace the lamp with the motor (M1, “+” side on top) and fan; the motor will spin if there is sunlight on the solar cell.

WARNING: Moving parts. Do not touch the fan or motor during operation. Do not lean over the motor.

Project #551 — Solar Resistance Meter



OBJECTIVE: To test the resistance of your components.

Place the circuit near a bright light and set the adjustable resistor (RV) so that the meter (M2) reads “10” on the LOW (or 10mA) setting. Now replace the 3-snap between points A & B with another component to test, such as a resistor, capacitor, motor, photoresistor, or lamp. The 100μF (C4) or 470μF (C5) capacitors will give a high reading that slowly drops to zero.

You can also use the two-spring socket (?1) and place your own components between its springs to test them.

Project #552 — Solar Diode Tester

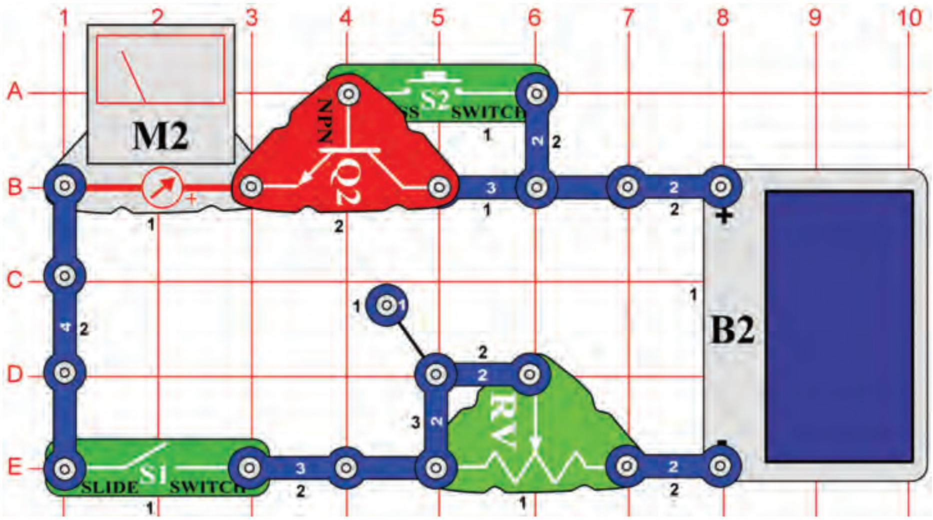
OBJECTIVE: To learn about solar power.

Use the same circuit to test the red and green LED’s (D1 & D2), and the diode (D3). The diode will give a higher meter reading than the LED’s, and all three will block current in one direction.

Project #553

Solar NPN Transistor Tester

OBJECTIVE: To test your NPN transistor.



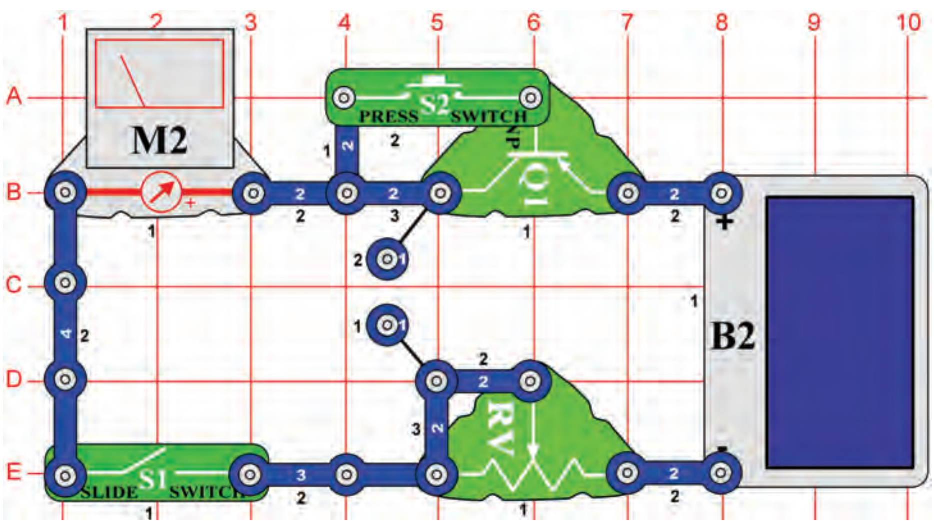
This circuit is just like the one in project #551, but tests the NPN transistor (Q2). The meter will read zero unless both switches (S1 & S2) are on, then the adjustable resistor (RV) sets the current. If you have the same light and RV setting as project #552 with the diode (D3), then the meter (M2) reading will be higher with the transistor.

You can replace the NPN transistor with the SCR (Q3), it works the same way in this circuit.

Project #554

Solar PNP Transistor Tester

OBJECTIVE: To test your PNP transistor.

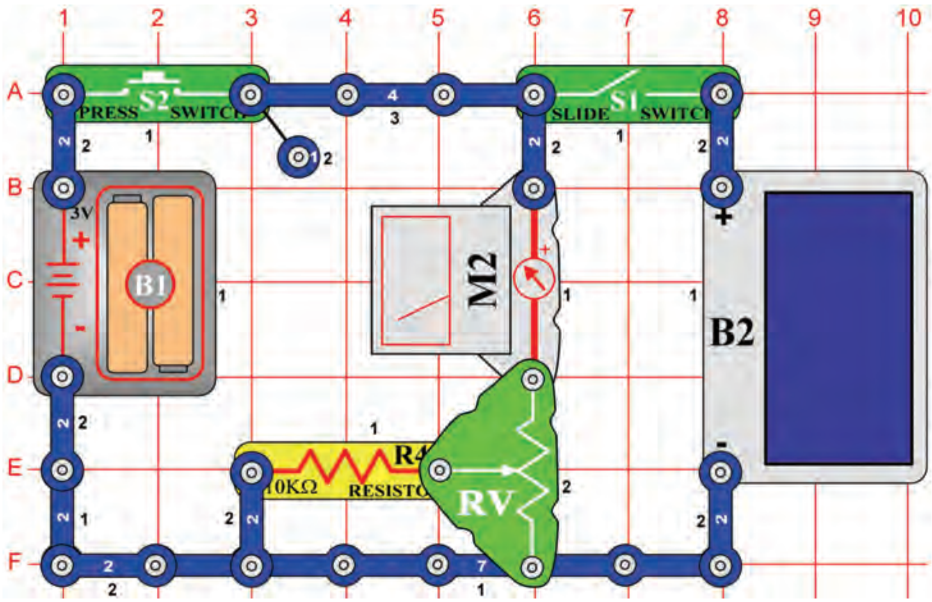


This circuit is just like the one in project #551, but tests the PNP transistor (Q1). The meter (M2) will read zero unless both switches (S1 & S2) are on, then the adjustable resistor (RV) sets the current. If you have the same light and RV setting as project #552 with the diode (D3), then the meter reading will be higher with the transistor.

☐ Project #555

Solar Cell vs. Battery

***OBJECTIVE:** To compare the voltage of the solar cell to the battery.*



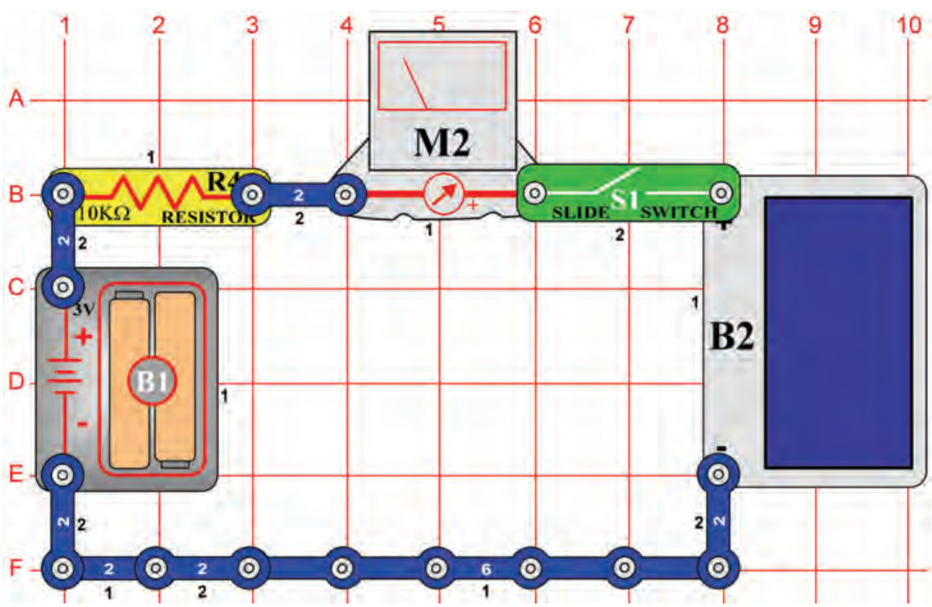
Set the meter (M2) to the LOW (or 10mA) scale. Press the press switch (S2) and set the adjustable resistor (RV) so that the meter reads “5”, then release it.

Now turn on the slide switch (S1) and vary the brightness of light to the solar cell (B2). Since the voltage from the batteries (B1) is 3V, if the meter reads higher than “5”, then the solar cell voltage is greater than 3V. If the solar cell voltage is greater and you have rechargeable batteries (in B1), then turning on both switches at the same time will use the solar cell to recharge your batteries.

☐ Project #556

Solar Cell vs. Battery (II)

***OBJECTIVE:** To compare the voltage of the solar cell to the battery.*



Set the meter (M2) to the LOW (or 10mA) scale. Turn on the slide switch (S1) and vary the brightness of light to the solar cell (B2). If the meter reads zero, then the battery voltage is higher than the voltage produced by the solar cell.

If the meter reads greater than zero, then the solar cell voltage is higher. If the batteries are rechargeable then the solar cell will recharge them until the voltages are equal.

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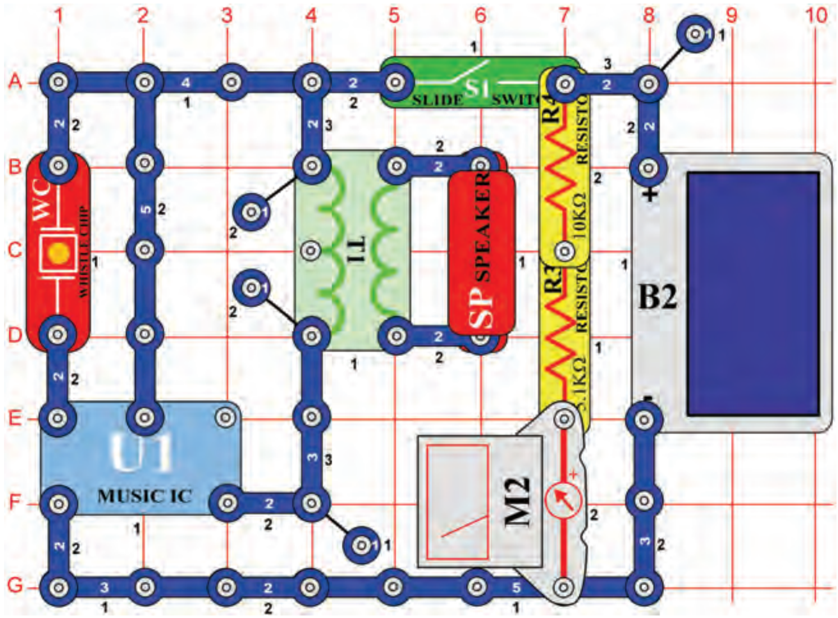
Project #557 Solar Music

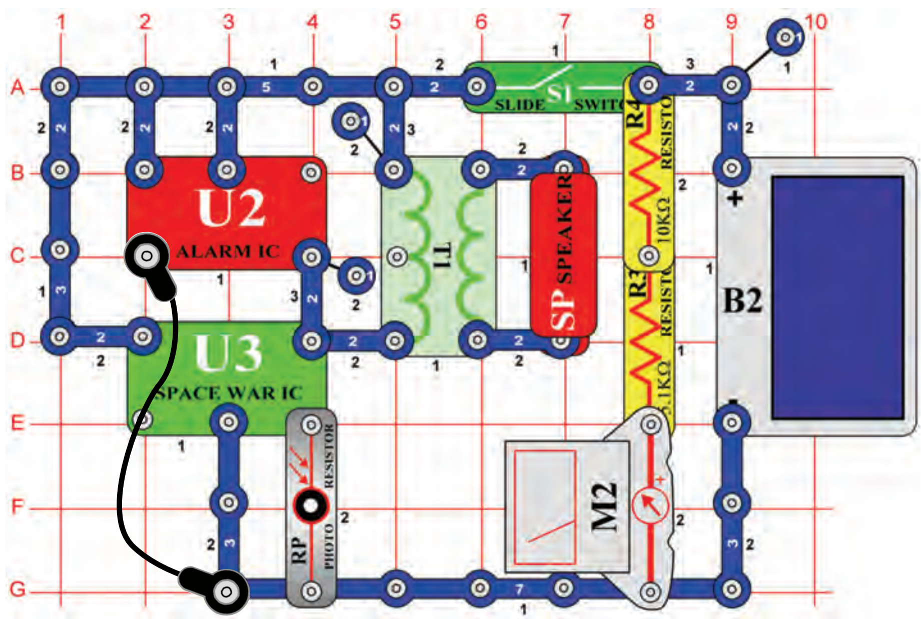


OBJECTIVE: To use the sun to make music.

Set the meter (M2) to the LOW (or 10mA) scale. With the slide switch (S1) off, make sure you have enough light on the solar cell (B2) for the meter to read 7 or higher. Now turn on the slide switch and listen to the music. When it stops, clap your hands and it should resume.

The meter is used to measure if the solar cell can supply enough current to operate the music IC (U1).

Project #558 Solar Sounds Combo

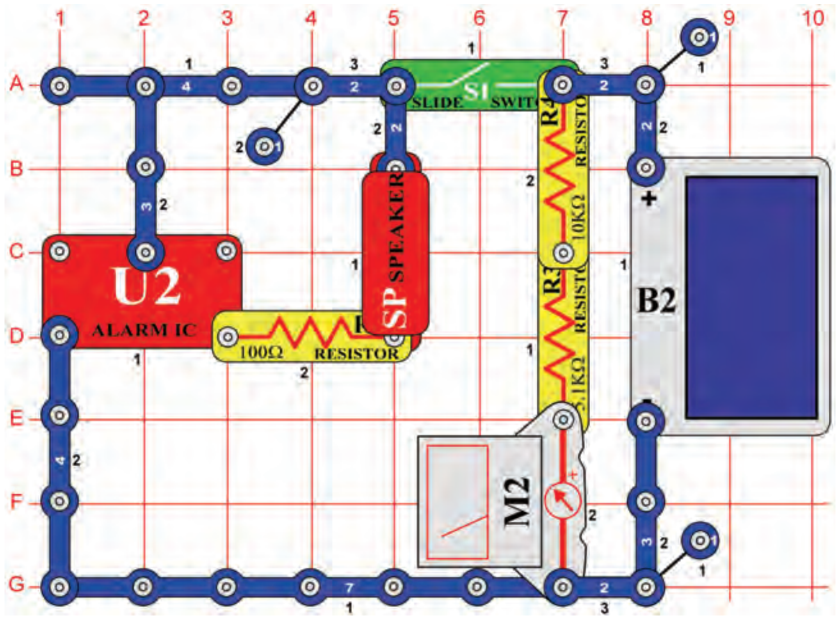


OBJECTIVE: To use the sun to make sounds.

Set the meter (M2) to the LOW (or 10mA) scale. With the slide switch (S1) off, make sure you have enough light on the solar cell (B2) for the meter to read 9 or higher. Now turn on the slide switch and listen to sounds from the alarm (U2) and space war (U3) IC's. Wave your hand over the photoresistor (RP) to change the sounds.

The meter is used to measure if the solar cell can supply enough current to operate the alarm and space war IC's. This project needs more light than project #557, since two IC's are used here.

Project #559 — Solar Alarm

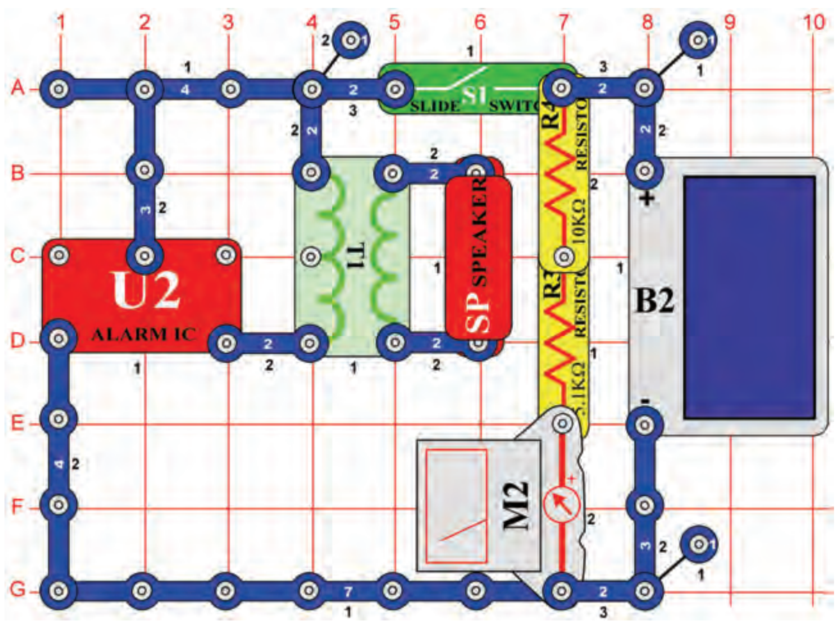


OBJECTIVE: To use the sun to make alarm sounds.

Set the meter (M2) to the LOW (or 10mA) scale. With the slide switch (S1) off, make sure you have a bright light on the solar cell (B2) so the meter reads 10 or higher. Now turn on the slide switch and listen to the sound.

The meter is used to measure if the solar cell can supply enough current to operate the alarm IC (U2). Some types of light are better than others, but bright sunlight is best.

Project #560 — Better Solar Alarm



OBJECTIVE: To use the sun to make alarm sounds.

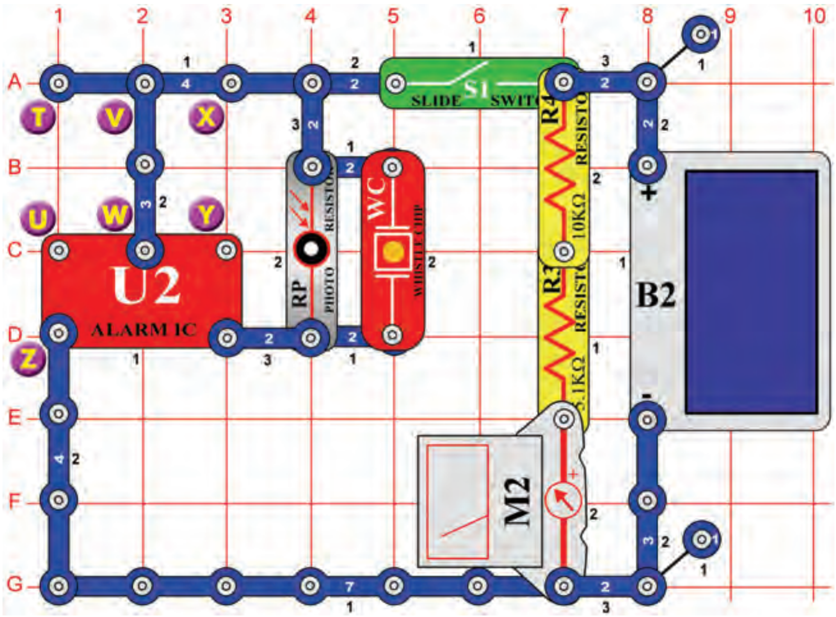
Set the meter (M2) to the LOW (or 10mA) scale. With the slide switch (S1) off, make sure you have enough light on the solar cell (B2) for the meter to read 8 or higher. Now turn on the slide switch and listen to the sound.

This circuit uses the transformer (T1) to boost the current to the speaker (SP), allowing it to operate with less power from the solar cell. Compare how much light it needs to project #559, which doesn't have a transformer.

You can change the sound from the alarm IC (U2) using the same variations listed in projects #61-65.

Project #561 — Photo Solar Alarm

OBJECTIVE: To use the sun to make alarm sounds.



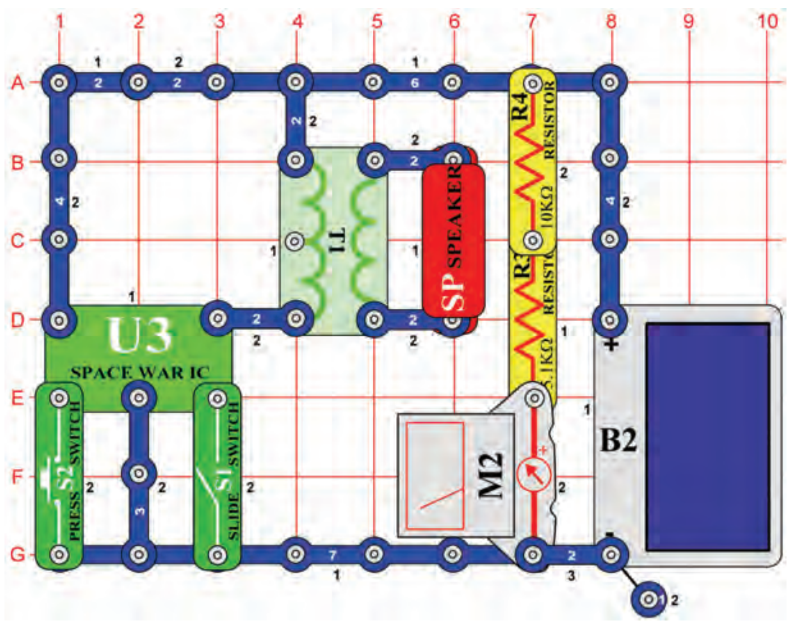
Set the meter (M2) to the LOW (or 10mA) scale. With the slide switch (S1) off, make sure you have enough light on the solar cell (B2) for the meter to read 6 or higher. Now turn on the slide switch and listen to the alarm. Cover the photoresistor (RP) to stop the alarm.

The whistle chip (WC) needs less power to make noise than the speaker (SP), so this circuit can operate with less light on the solar cell than projects #559 and #560. But the sound from the circuits with the speaker is louder and clearer.

You can change the sound from the alarm IC (U2) using the same variations listed in projects #61-65.

Project #562 — Solar Space War

OBJECTIVE: To use the sun to make space war sounds.



Set the meter (M2) to the LOW (or 10mA) scale. With the slide switch (S1) off, make sure you have enough light on the solar cell (B2) for the meter to read 8 or higher. Now turn on the slide switch and listen to the space war sounds.

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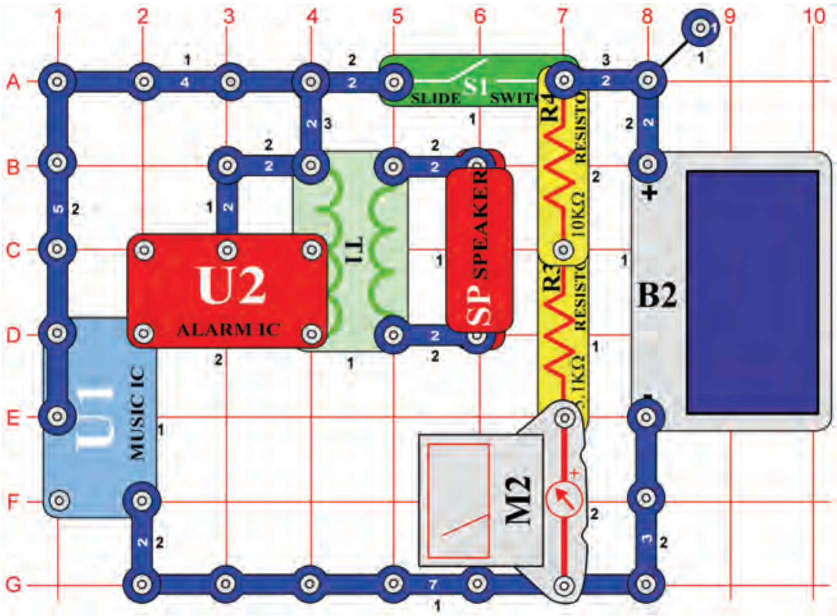
Project #563



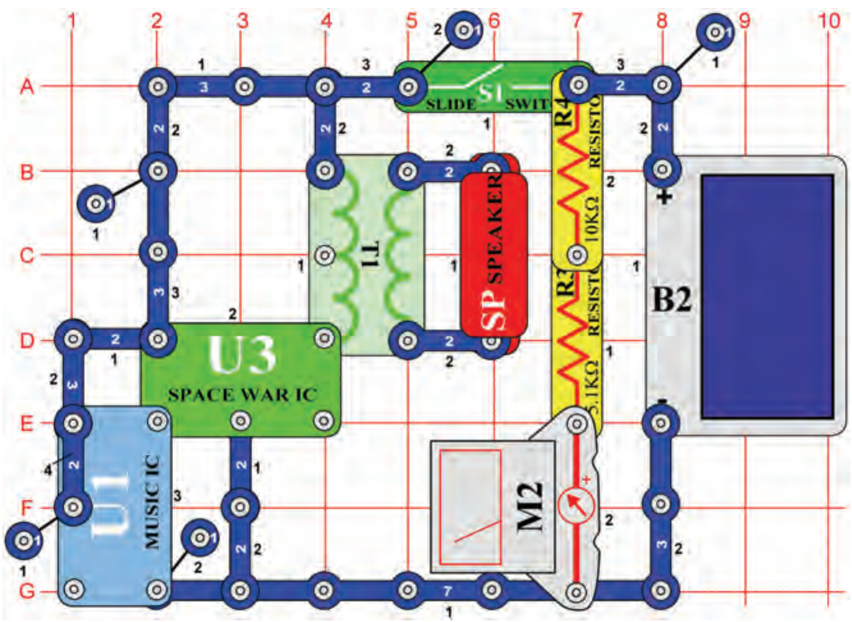
Solar Music Alarm Combo

OBJECTIVE: To use the sun to make a combination of sounds.

Set the meter (M2) to the LOW (or 10mA) scale. With the slide switch (S1) off, make sure you have enough light on the solar cell (B2) for the meter to read 8 or higher. Now turn on the slide switch and listen to the music.

The meter is used to measure if the solar cell can supply enough current to operate the ICs (U1 & U2).

Project #564



Solar Music Space War Combo

OBJECTIVE: To use the sun to make a combination of sounds.

Set the meter (M2) to the LOW (or 10mA) scale. With the slide switch (S1) off, make sure you have enough light on the solar cell (B2) for the meter to read 8 or higher. Now turn on the slide switch and listen to the music.

Project #565

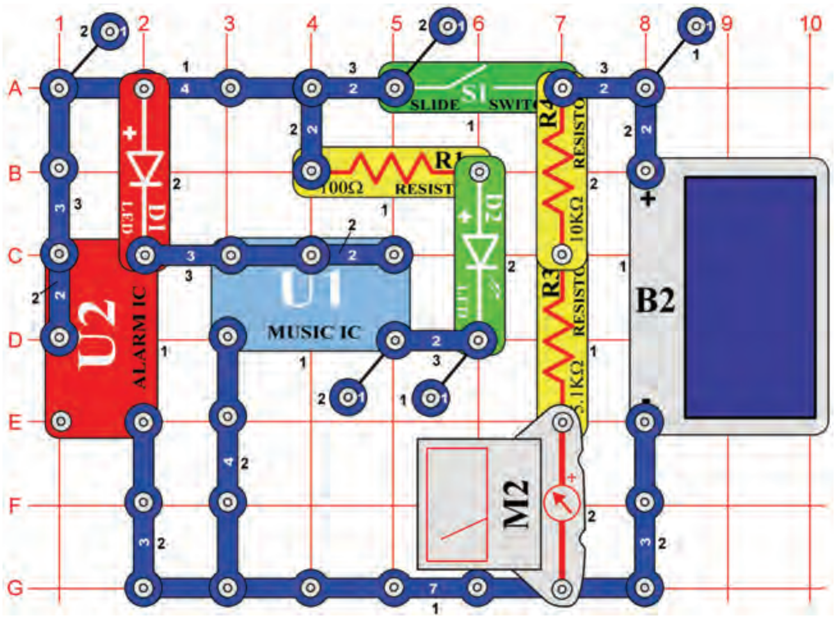
Solar Music Space War Combo (II)

OBJECTIVE: To use the sun to make a combination of sounds.

Use the circuit from project #564 but replace the speaker (SP) with the whistle chip (WC). Now the light on the solar cell (B2) doesn't have to be as bright for this circuit to work. You can also modify this circuit by replacing the music IC (U1) with the alarm IC (U2).

Project #566 Solar Periodic Lights

OBJECTIVE: To use the sun to flash lights in a repeating pattern.



Set the meter (M2) to the LOW (or 10mA) scale. With the slide switch (S1) off, make sure you have enough light on the solar cell (B2) for the meter to read 9 or higher. Now turn on the slide switch and the LED's (D1 & D2) will alternate being on and off.

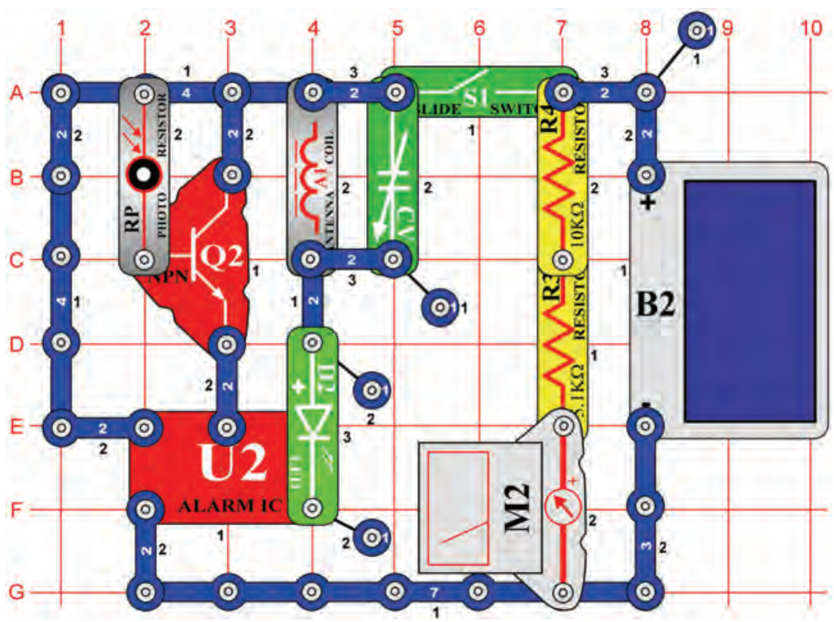
Project #567 Solar Periodic Lights (II)

OBJECTIVE: To use the sun to flash lights in a repeating pattern.

Use the circuit in project #566, except remove the 3-snap between the music (U1) and alarm (U2) IC's (base grid locations C2-C4) and add a 2-snap between the music IC and the 100Ω resistor (R1) (base grid B4-C4). The circuit works the same way but the LED flashing patterns are different.

Project #568 Solar AM Radio Transmitter

OBJECTIVE: To use the sun to power an AM radio transmitter.

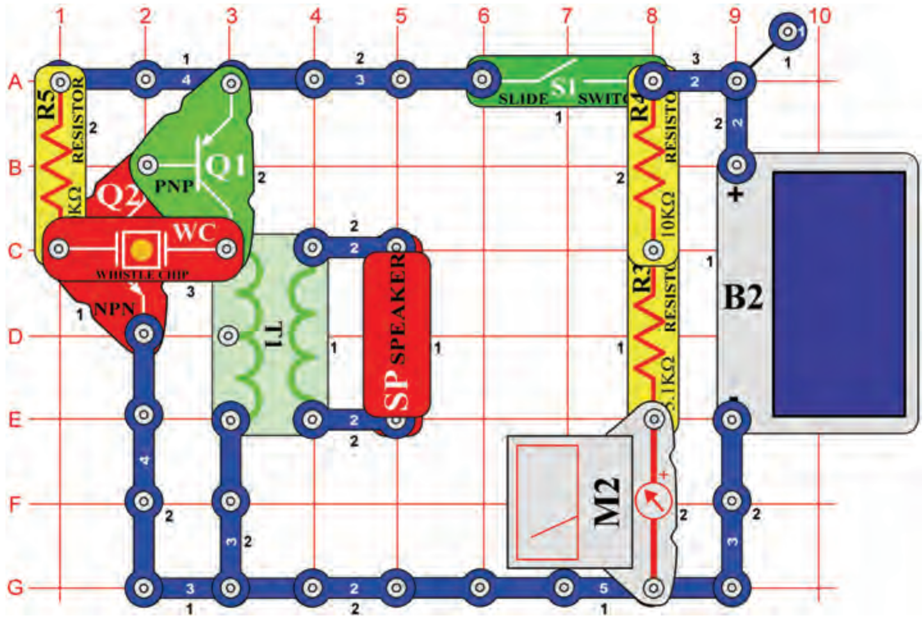


You need an AM radio for this project. Place it next to your circuit and tune the frequency to where no other station is transmitting.

Set the meter (M2) to the LOW (or 10mA) scale. With the slide switch (S1) off, make sure you have enough light on the solar cell (B2) for the meter to read 9 or higher. Turn on the slide switch and adjust the variable capacitor (CV) for the best sound on the radio. Cover the photoresistor (RP) to change the sound pattern.

Project #569 Low Light Noisemaker

OBJECTIVE: To build a sun-powered oscillator circuit.



Set the meter (M2) to the LOW (or 10mA) scale. With the slide switch (S1) off, make sure you have light on the solar cell (B2) for the meter to read at least 5 but less than 10.

Turn on the slide switch and it should make a whining sound, adjust the amount of light to the solar cell to change the frequency of the sound. Use a brighter light or partially cover the solar cell if there is no sound at all.

Project #570 Low Light Noisemaker (II)

OBJECTIVE: To build a sun-powered oscillator circuit.

Use the circuit from project #569 but replace the whistle chip (WC) with the 0.1μF capacitor (C2) to lower the frequency of the sound. The circuit works the same way.

Project #571 Low Light Noisemaker (III)

OBJECTIVE: To build a sun-powered oscillator circuit.

Use the circuit from project #569 but replace the whistle chip (WC) with the 10μF capacitor (C3, "+" on the right) to lower the frequency of the sound. The circuit works the same way but you hear a ticking sound instead of a whining sound.

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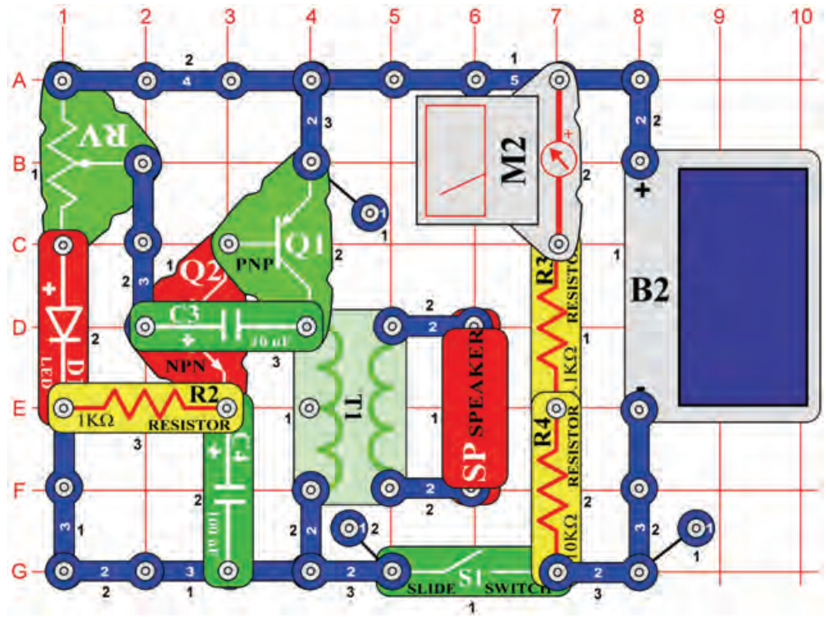
Project #572 Solar Oscillator



OBJECTIVE: To build a sun-powered oscillator circuit.

Set the meter (M2) to the LOW (or 10mA) scale. With the slide switch (S1) off, make sure you have enough light on the solar cell (B2) for the meter to read 8 or higher. Now turn on the slide switch and adjust the adjustable resistor (RV).

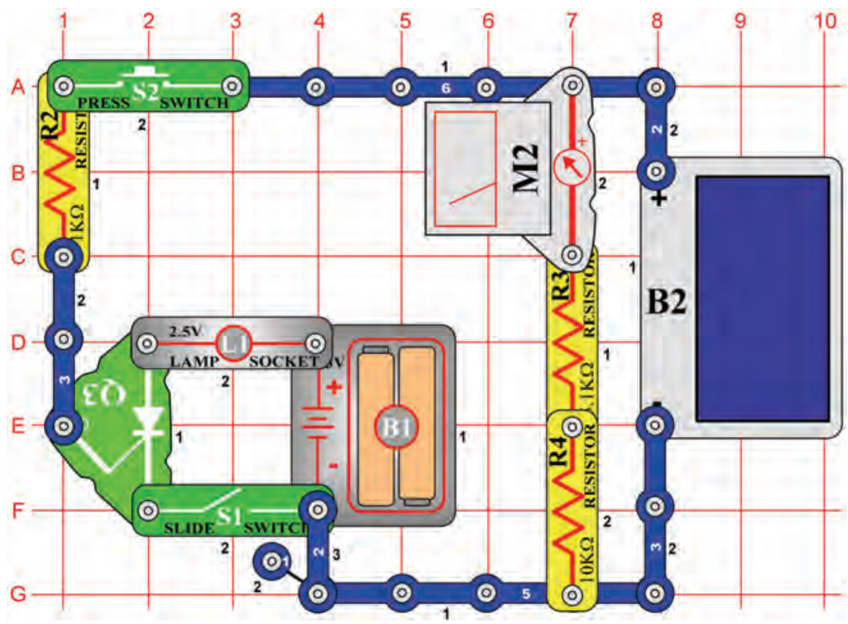
You will hear a clicking sound like raindrops or a whine, depending upon how much light there is.

Project #573 Solar Oscillator (II)

OBJECTIVE: To build a sun-powered oscillator circuit.

Use the circuit from project #572 but replace the 10μF capacitor (C3) with the 0.02μF or 0.1μF capacitors (C1 & C2) to make the sound a high-pitch whine.

Project #574 Daylight SCR Lamp



OBJECTIVE: To learn the principle of an SCR.

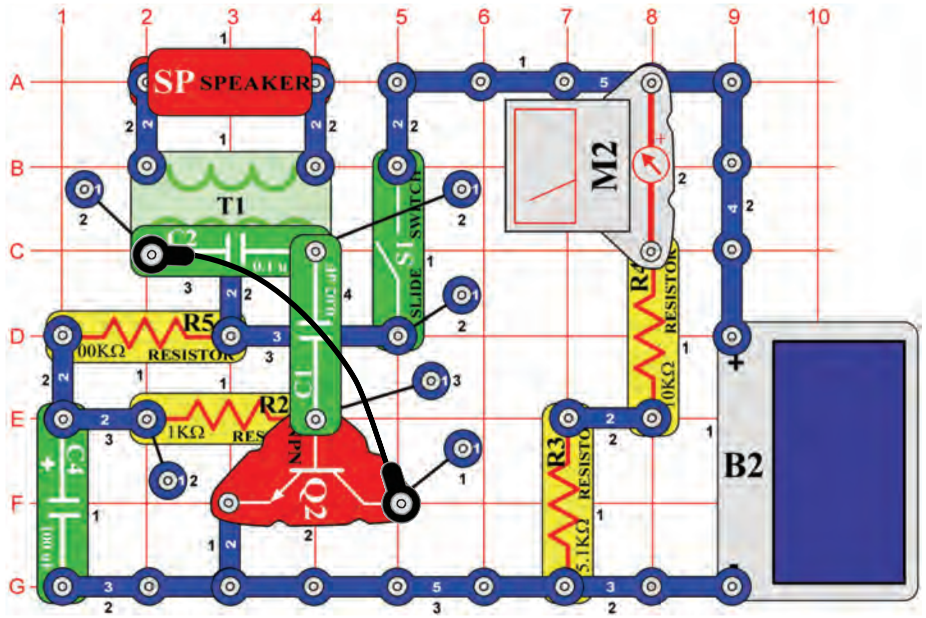
Set the meter (M2) to the LOW (or 10mA) scale. Make sure you have enough light on the solar cell (B2) for the meter to read 3 or higher.

Turn on the slide switch (S1), the lamp (L1) stays off. Push the press switch (S2) and the SCR (Q3) turns on the lamp and keeps it on. You must turn off the slide switch to turn off the lamp.

The SCR is a controlled diode. It lets current flow in one direction, and only after a voltage pulse is applied to its control pin. This circuit has the control pin connected to the press switch and solar cell, so you can't turn it on if the room is dark.

Project #575 — Solar Bird Sounds

OBJECTIVE: To build a sun-powered oscillator circuit.

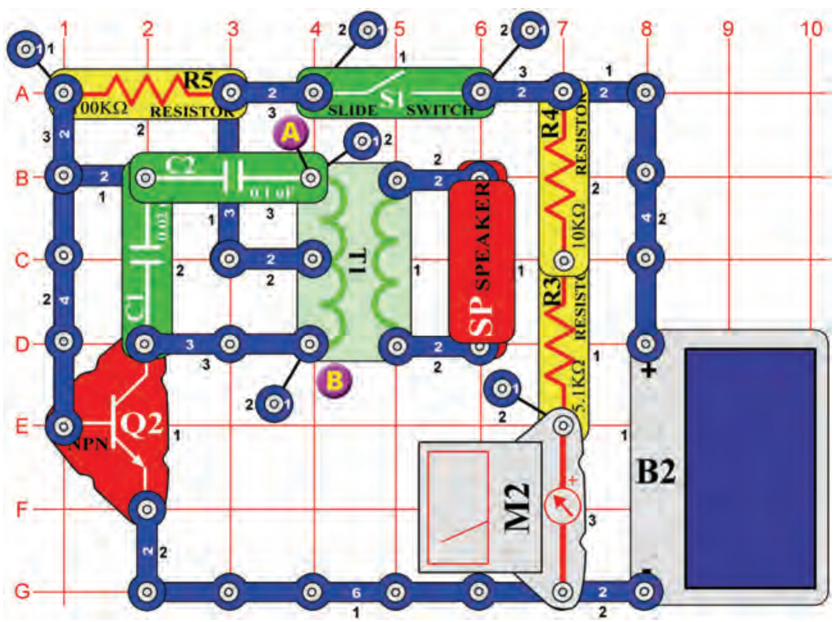


Set the meter (M2) to the LOW (or 10mA) scale. With the slide switch (S1) off, make sure you have enough light on the solar cell (B2) for the meter to read 9 or higher. Now turn on the slide switch and listen to the sound.

For variations on this circuit, replace the 100µF capacitor (C4) with the 10µF capacitor (C3) or replace the speaker (SP) with the whistle chip (WC).

Project #576 — Solar Bird Sounds (II)

OBJECTIVE: To build a sun-powered oscillator circuit.



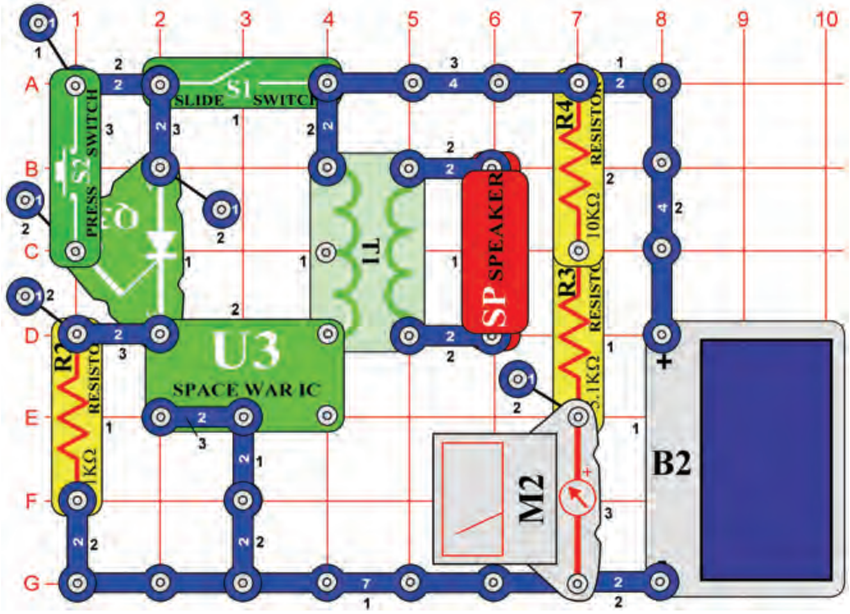
Set the meter (M2) to the LOW (or 10mA) scale. With the slide switch (S1) off, make sure you have enough light on the solar cell (B2) for the meter to read 9 or higher. Now turn on the slide switch and listen to the sound.

For variations on this circuit, install the whistle chip (WC) above the 0.02µF capacitor (C1), or install it across points A & B and remove the speaker (SP).

Project #577

SCR Solar Bomb Sounds

OBJECTIVE: To learn the principle of an SCR.

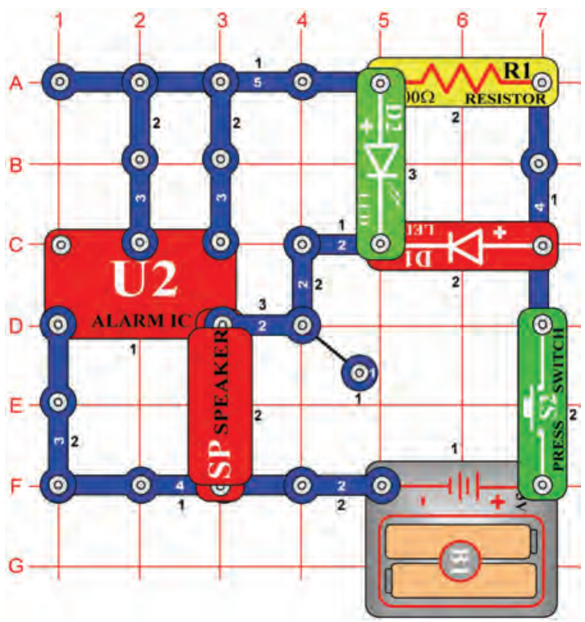


Set the meter (M2) to the LOW (or 10mA) scale. With the slide switch (S1) off, make sure you have enough light on the solar cell (B2) for the meter to read 8 or higher. Turn on the slide switch now; nothing happens. Press the press switch (S2) and you hear an explosion of sounds, which continues until you turn off the slide switch.

Project #578

Flashing Laser LED's with Sound

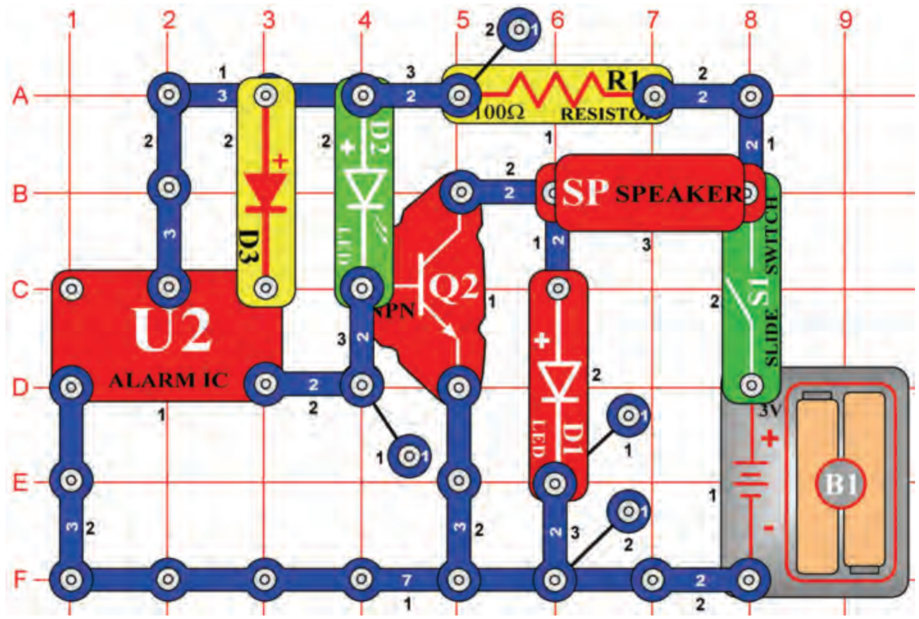
OBJECTIVE: To build a laser sounding circuit.



When you press the press switch (S2), the integrated circuit (U2) should sound like a laser gun. The red (D1) and green (D2) LED's will flash simulating a burst of light. You can shoot long repeating laser bursts or short zaps by tapping the press switch.

Project #579

U2 with Transistor Amplifier



OBJECTIVE: To combine U2 with an amplifier.

Turn the slide switch (S1) on and the LED's (D1 & D2) flash as the speaker (SP) sounds. The output pulses from U2 turns transistor Q2 on and off rapidly. As the transistor turns on, the speaker shorts to ground and a current flows through it. The current flow through the speaker causes it to produce a sound. The LED's show the pulsing signal from U2 that is turning Q2 on and off.

Project #580

U2 with Transistor Amplifier (II)

OBJECTIVE: To combine U2 with an amplifier.

Using project #579, remove the diode (D3) to create a different sound.

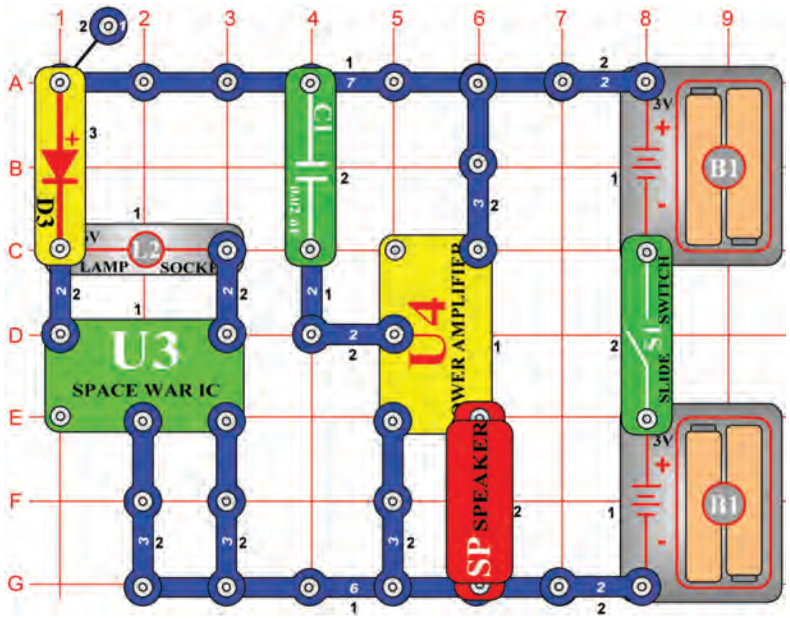
Project #581

U1 with Transistor Amplifier (III)

OBJECTIVE: To combine U1 with an amplifier.

Using the project #579, replace U2 with U1. The circuit will now play music.

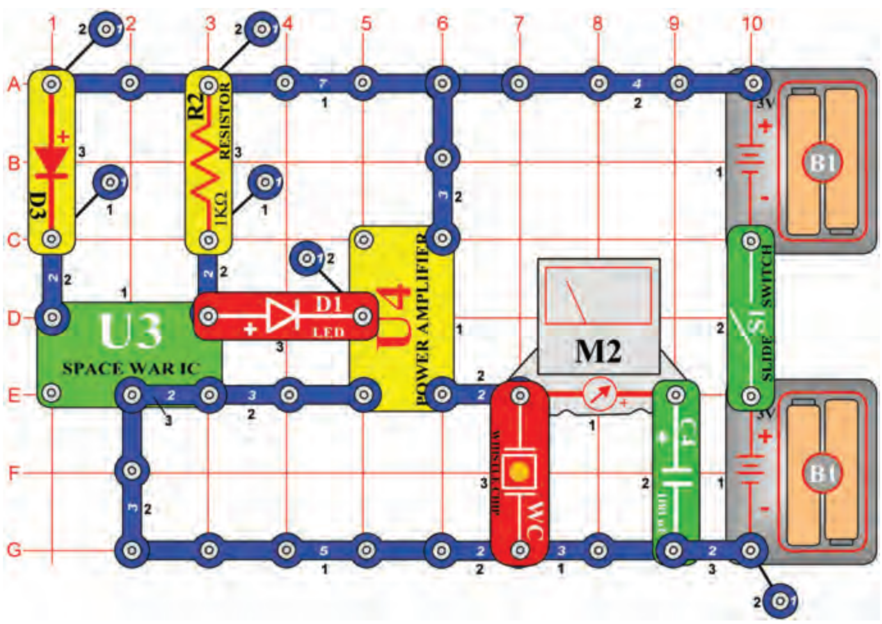
Project #582 — Loud Sounds



OBJECTIVE: To create a sound circuit.

Turn the slide switch (S1) on and you should hear a tone from the speaker (SP).

Project #583 — Swinging Meter with Sound

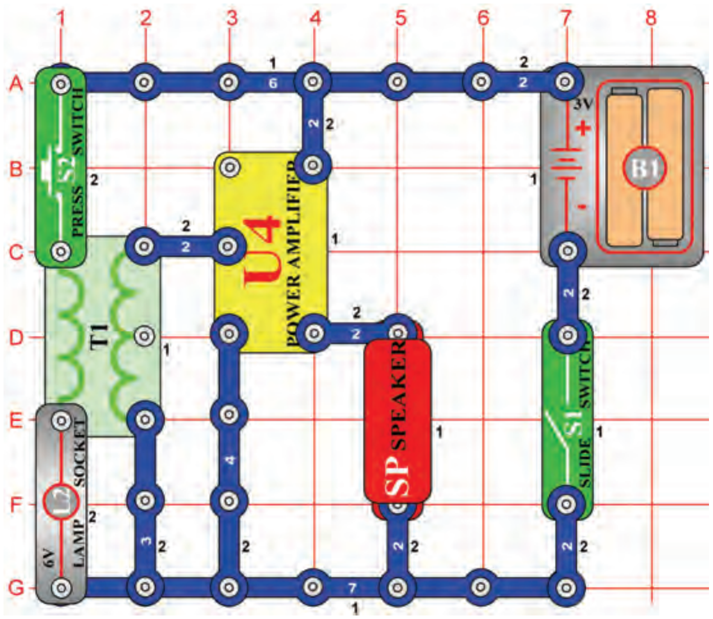


OBJECTIVE: To see and hear the output from the Space War

Set the meter (M2) to the LOW (or 10mA) scale. In this project, you will see and hear the output from the space war IC (U3). The power amplifier IC (U4) amplifies the signal from U3 in order to drive the whistle chip (WC) and meter. Turn on the slide switch (S1). The meter deflects back and forth, as the LED (D1) flashes and the whistle chip sounds. Replace the whistle chip with the speaker (SP) for a louder sound. Note that the meter will deflect very little now. Almost all the signal is across the speaker due to its low resistance.

Project #584

Motor Sound Using Transformer



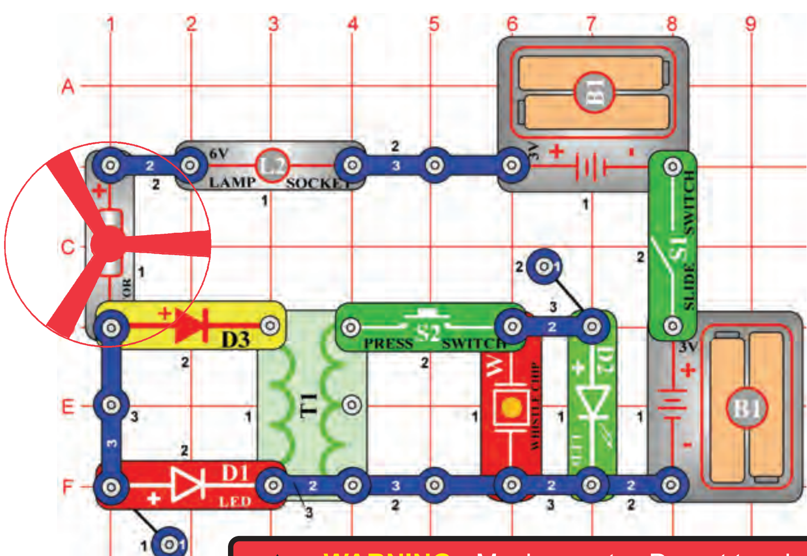
OBJECTIVE: To create a sound circuit.

Turn the slide switch (S1) on and then rapidly turn on and off the press switch (S2). This causes a magnetic field to expand and collapse in the transformer (T1). The small voltage generated is then amplified by the power amplifier IC (U4) and the speaker (SP) sounds. Replace switch S2 with the motor (M1, leave the fan off) and you can hear how fast the motor spins. To hear the sound better, connect the speaker to the circuit using the red and black jumper wires (instead of the 2-snaps) and hold it next to your ear.

WARNING: Moving parts. Do not touch the fan or motor during operation.

Project #585

Motor Sound with LED



WARNING: Moving parts. Do not touch the fan or motor during operation. Do not lean over the motor.

OBJECTIVE: To create a sound circuit.

In this project, you will drive the whistle chip (WC) and LED's using the motor (M1) and transformer (T1). Turn the slide switch (S1) on. The motor begins spinning and the red LED (D1) lights. Now press the press switch (S2), the voltage generated from the transformer is now across the whistle chip and green LED (D2). The whistle chip sounds as the green LED lights.

Project #586

Motor Sound with LED (II)

OBJECTIVE: To create a sound circuit.

Modify project #585 by replacing the 6V lamp (L2) with the speaker (SP). Now the speaker (SP) will also output sound.

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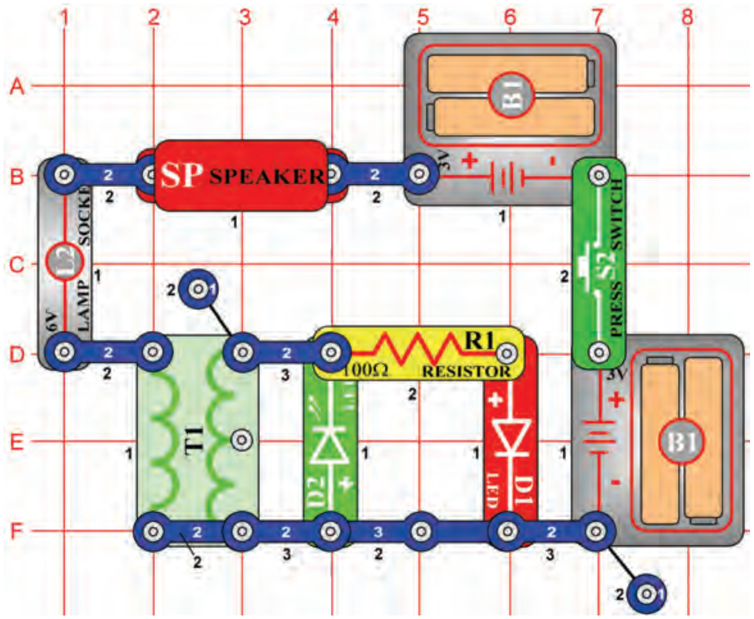
Project #587 — AC & DC Current

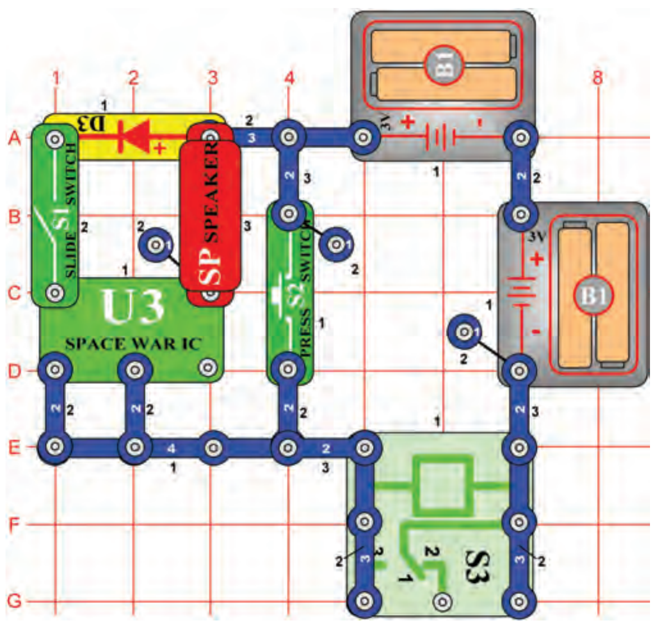
OBJECTIVE: Using AC and DC current.



This circuit creates an AC & DC current. Press the press switch (S2) a few times and the LED's flash back and forth. Turning the switch on and off causes the magnetic field in the transformer (T1) to expand (green LED D2 lights) and collapse (red LED D1 lights) and current flows in two directions. Hold the switch down and the green LED flashes once. Replace the 6V lamp (L2) with the motor (M1). Press the press switch, the red LED flickers and the speaker sounds, due to the small current change from the motor spinning.

Project #588 — Noisemaker

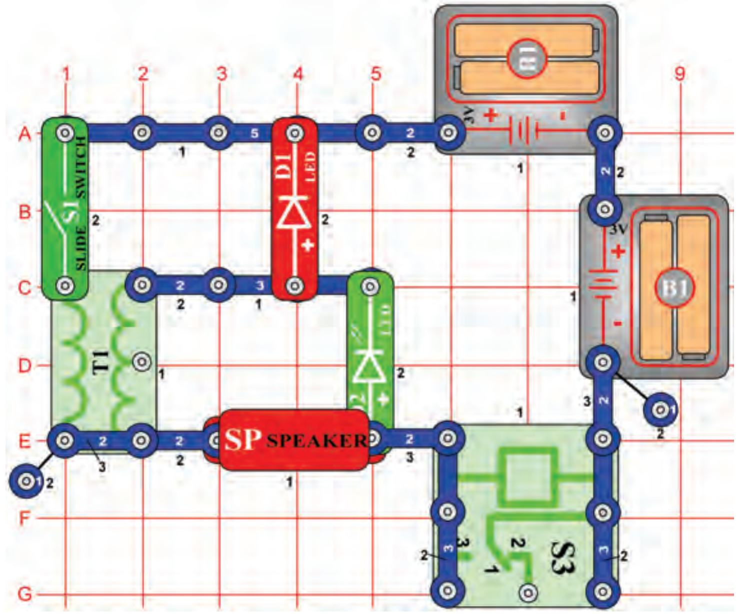
OBJECTIVE: To create a sound circuit.



Turn on the slide switch (S1) and the relay (S3) generates a buzzing noise. Increase the voltage across the relay by pressing the press switch (S2). The tone is higher because the relay's contacts are opening and closing faster.

Project #589 — AC Voltage

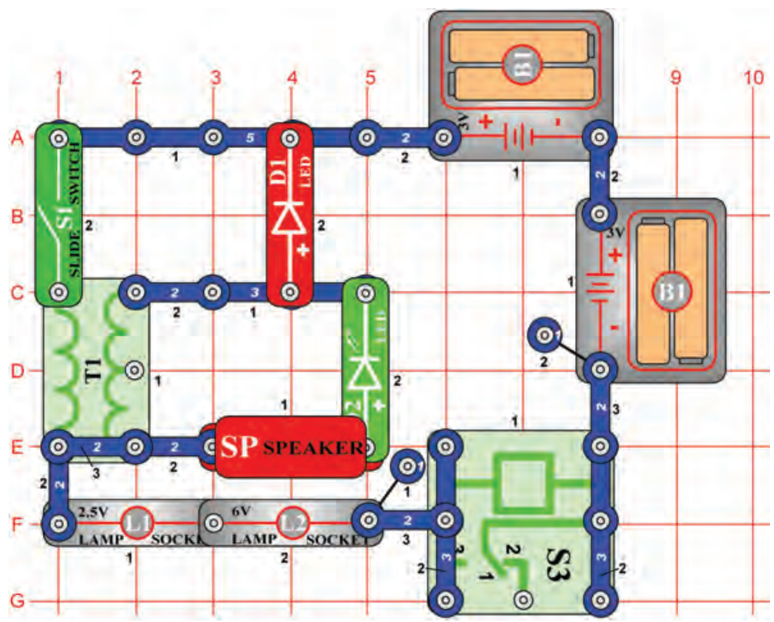
OBJECTIVE: To use AC voltage.



Turn the slide switch (S1) on. The LED's (D1 & D2) flash so fast that they appear to be on, and the speaker (SP) sounds. As in other projects, the relay's (S3) contacts open and close rapidly. This causes the magnetic field in the transformer (T1) to expand and collapse, creating an AC voltage lighting the LED's.

Project #590 — AC Voltage (II)

OBJECTIVE: To use AC voltage.

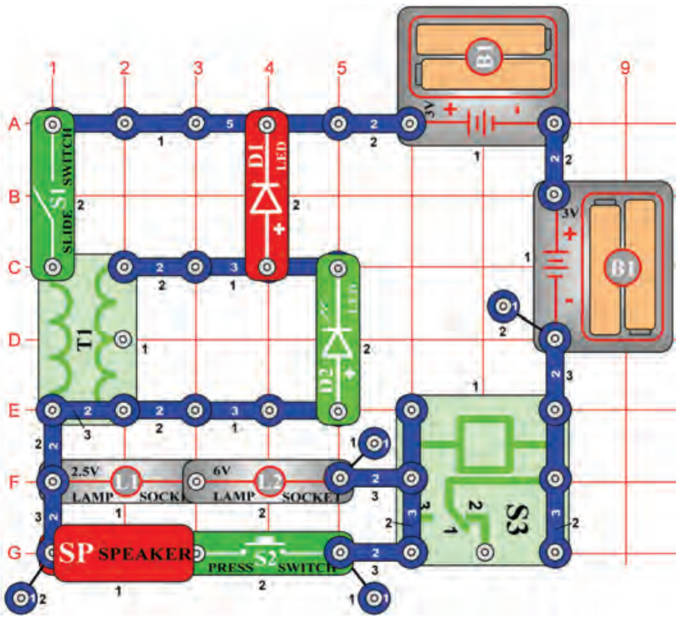


You can modify project #589 by adding two light bulbs (L1 & L2). When the slide switch (S1) is turned on, the relay (S3) sounds and the light bulbs and LED's (D1 & D2) flash.

Project #591

AC Voltage (III)

OBJECTIVE: To use AC voltage.

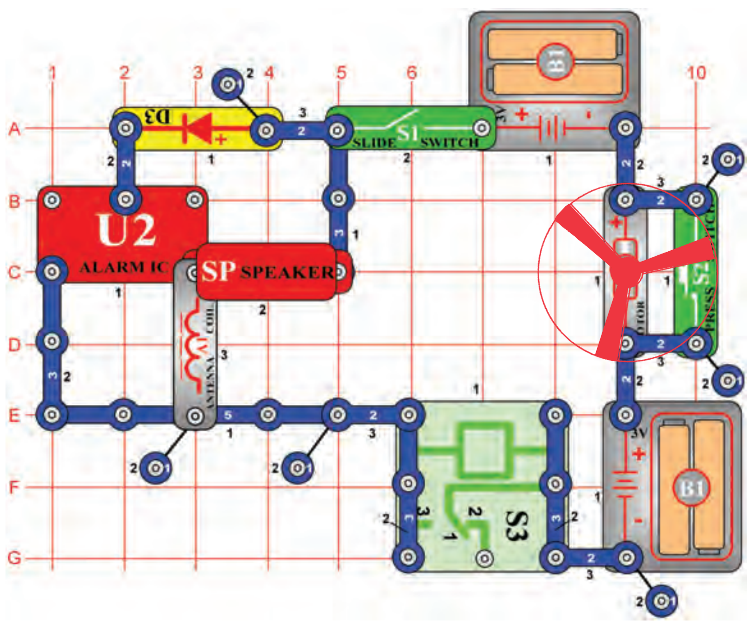


This project is similar to project #589. When the slide switch (S1) is turned on, the relay (S3) sounds and the light bulbs (L1 & L2) and LED's (D1 & D2) flash. Now when the press switch (S2) is pressed, the speaker (SP) also sounds.

Project #592

Noisemaker (II)

OBJECTIVE: To create a sound circuit.

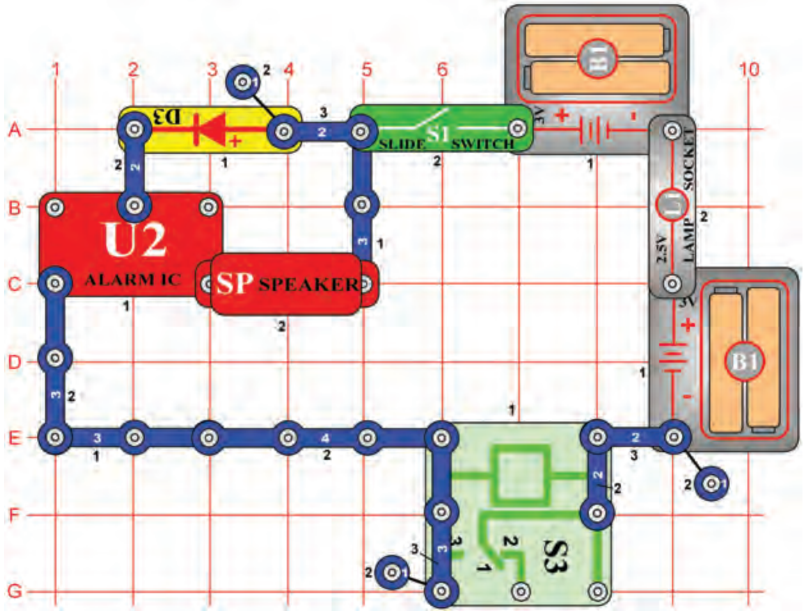


Turn on the slide switch (S1) and the relay (S3) generates a buzzing noise. Increase the voltage across the relay by pressing the press switch (S2). The tone changes because the relay's contacts are opening and closing faster.

WARNING: Moving parts. Do not touch the fan or motor during operation. Do not lean over the motor.

Project #593 — Noisemaker (III)

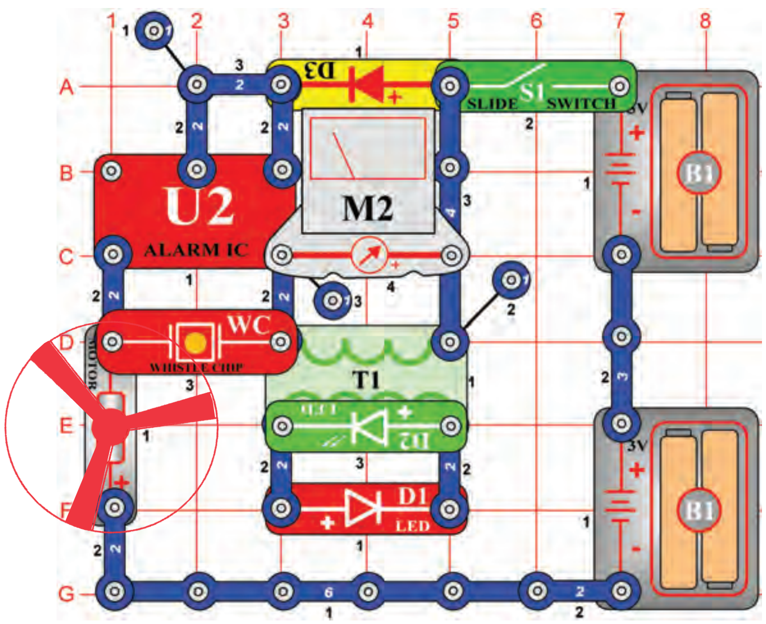
OBJECTIVE: To create a sound circuit.



Turn the slide switch (S1) on and the speaker (SP) sounds as if a motor is spinning and an alarm is running. The relay's (S3) contacts rapidly open and close the battery connection to the circuit causing the alarm IC (U2) to sound to be different.

Project #594 — Pulsing Motor

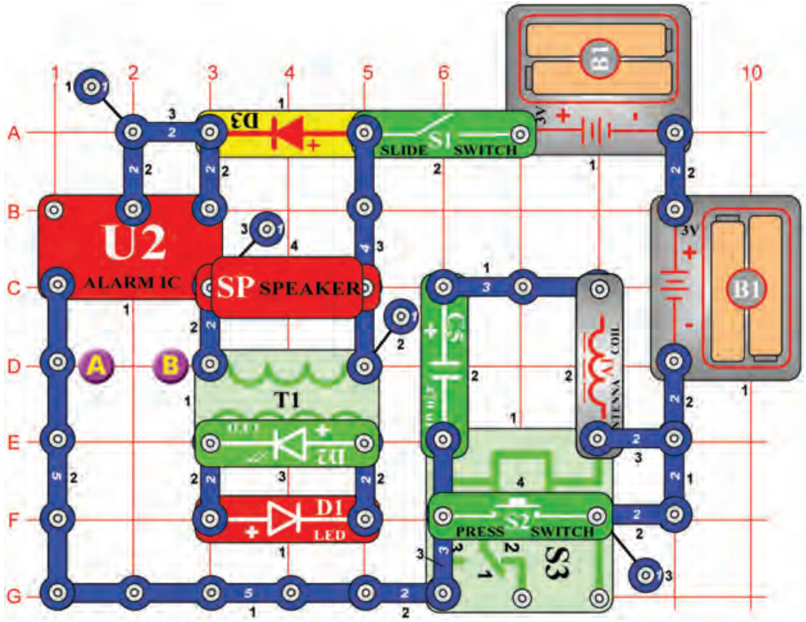
OBJECTIVE: To create a pulsing motor circuit.



Set the meter (M2) to the LOW scale. Turn on the slide switch (S1) and now you have a pulsing motor and LED's circuit. Replace the meter with the 470μF capacitor (C5, "+" on right) to change the rate the LED's (D1 & D2) flash.

WARNING: Moving parts. Do not touch the fan or motor during operation. Do not lean over the motor.

Project #595 Noisemaker (IV)



OBJECTIVE: To create a sound circuit.

In this project, you'll see and hear the output of the alarm IC (U2). Turn on the slide switch (S1), the LED's (D1 & D2) flash, and the speaker (SP) sounds as the relay (S3) chatters. Now press the press switch (S2) and see what happens when you remove the relay from the circuit.

Project #596 Noisemaker (V)

OBJECTIVE: To create a sound circuit.

Modify the sound of project #595 by adding capacitor C4 across points A & B (+ of C4 on right).

Project #597 Noisemaker (VI)

OBJECTIVE: To create a sound circuit.

Modify project #596 by replacing the capacitor C4 with the motor (M1, position it with the "+" on the left and don't place the fan on it). Turn on the slide switch (S1), the LED's flash, and the speaker (SP) sounds as the relay (S3) chatters. Now press the press switch (S2) removing the relay from the circuit, providing a constant connection to the battery (B1). The motor speeds up and the sound from the speaker is not distorted.

WARNING: Moving parts. Do not touch the fan or motor during operation. Do not lean over the motor.

Project #598 Noisemaker (VII)

OBJECTIVE: To create a sound circuit.

Modify project #597 replacing the speaker (SP) with the whistle chip (WC) and placing the fan onto the motor (M1). Turn on the slide switch (S1) and the fan spins, lights flash, and the relay (S3) chatters. Now try to launch the fan by pressing the press switch (S2) down for about five seconds and releasing it.

Project #599 Noisemaker (VIII)

OBJECTIVE: To create a sound circuit.

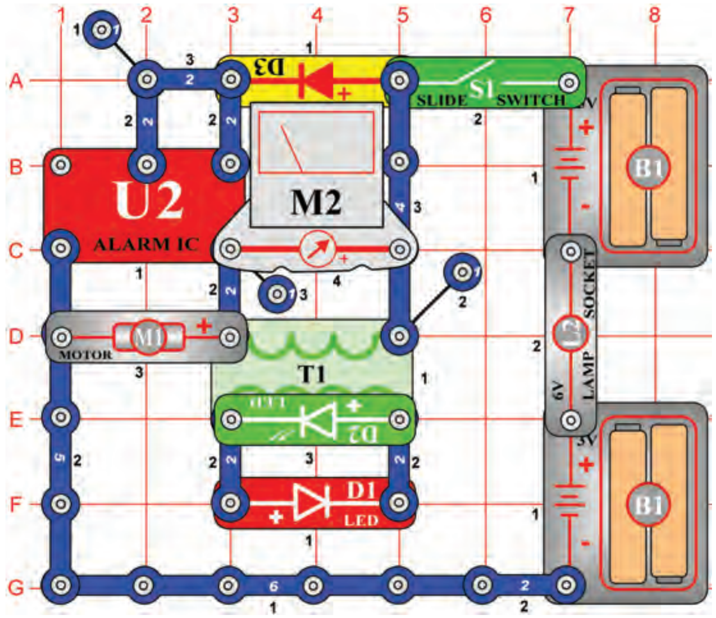
Modify project #598 by removing the motor (M1). Turn on the slide switch (S1) and press the press switch (S2) to hear the new sound.

Project #600 Noisemaker (IX)

OBJECTIVE: To create a sound circuit.

Modify the sound of project #599 by replacing the whistle chip (WC) with the meter (M2, "+" towards right), use the LOW (or 10mA) meter setting. Turn on the slide switch (S1) and as the LED's flash the meter deflects.

Project #601 — Alarm Power



OBJECTIVE: To create a sound circuit.

In this project, the alarm IC (U2) powers the motor (M1), meter (M2) and LED's (D1 & D2). Leave the fan off of the motor. Set the meter to the LOW (or 10mA) position and turn on the slide switch (S1). The circuit pulses the meter, motor, and LED's.

WARNING: Moving parts. Do not touch the motor during operation.

Project #602 — Alarm Power (II)

OBJECTIVE: To create a sound circuit.

Remove the motor (M1) from the circuit and now the circuit pulses around 1Hz.

Project #603 — Night Sounds

OBJECTIVE: To hear the sounds of the night.

Simulate the sound of a forest at night by replacing the motor (M1) in project #601 with the whistle chip (WC).

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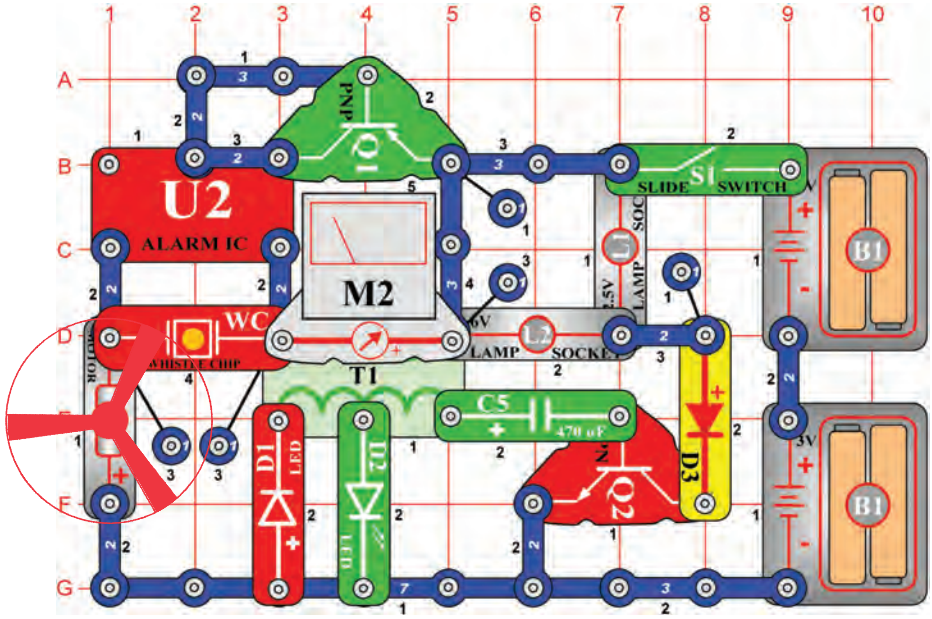
Project #604

Mega Pulser & Flasher

OBJECTIVE: To power other devices using the alarm IC.



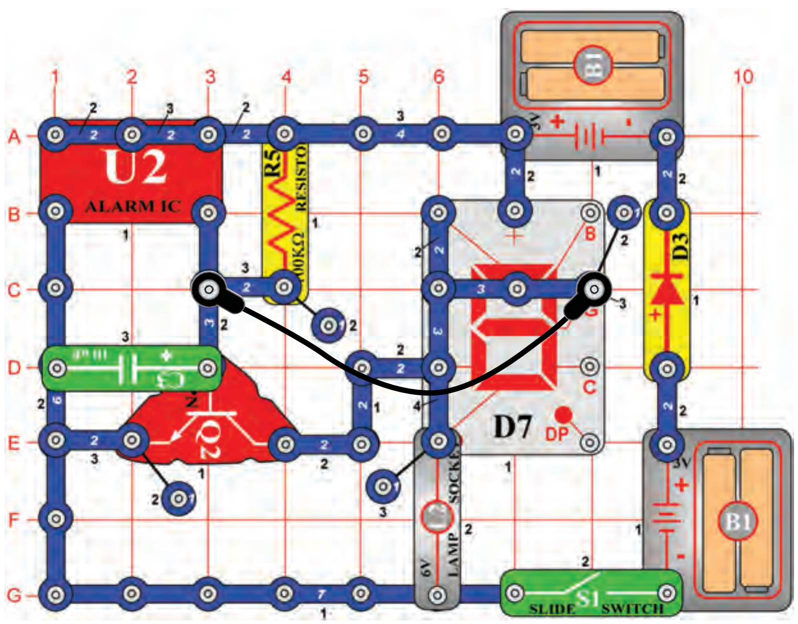
In this circuit, you will power many devices using the alarm IC (U2). Set the meter (M2) to LOW (or 10mA) and turn on the slide switch (S1). The LED's (D1 & D2) and bulbs (L1 & L2) flash, the meter deflects, the whistle chip (WC) sounds, and the motor (M1) spins.

WARNING: Moving parts. Do not touch the fan or motor during operation. Do not lean over the motor.

Project #605

"E" & "S" Blinker

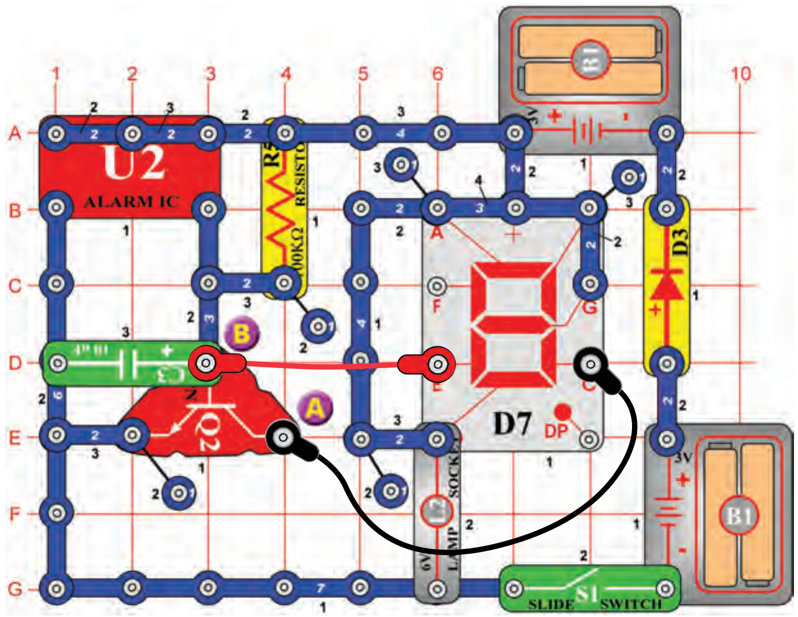
OBJECTIVE: To use the alarm IC to flash between "E" & "S".



This circuit alternately displays letters "E" and "S" by switching segments "E" and "C" on and off. Segments A, D, F, and G are connected to ground so they are always lit. Segment "C" is connected to the base of Q2 and output of U2. The segment "E" is connected to the collector of Q2. When the output of U2 is low, segment "C" is on and "E" is off. When the U2's output is high, the transistor (Q2) turns on and segment "C" turns off. When the transistor connects the "E" segment to ground the segment lights, displaying the letter "S".

☐ # Project #606 “2” & “3” Blinker

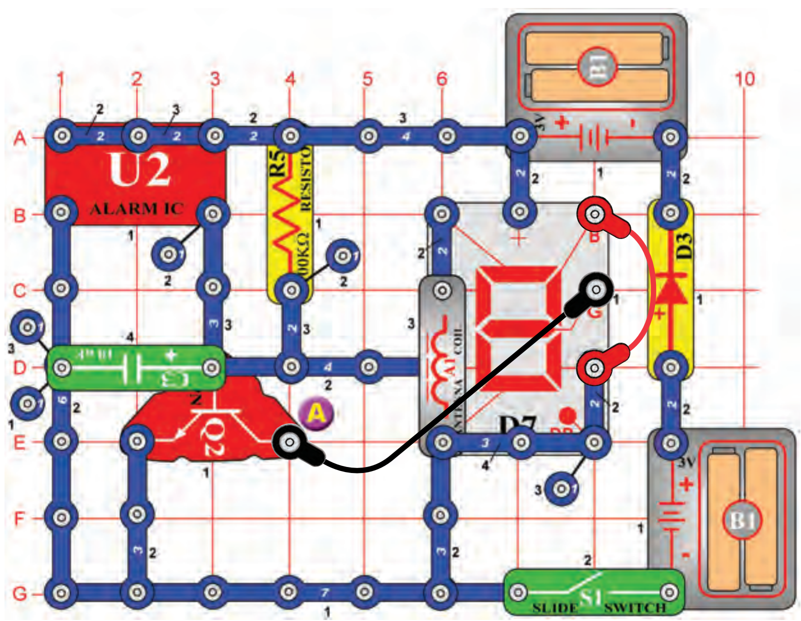
OBJECTIVE: To use the alarm IC to flash between “2” & “3”.



The circuit switches between numbers “2” & “3” on the display.
Place jumpers from point A to segment C and point B to segment E.

☐ # Project #607 “9” & “0” Blinker

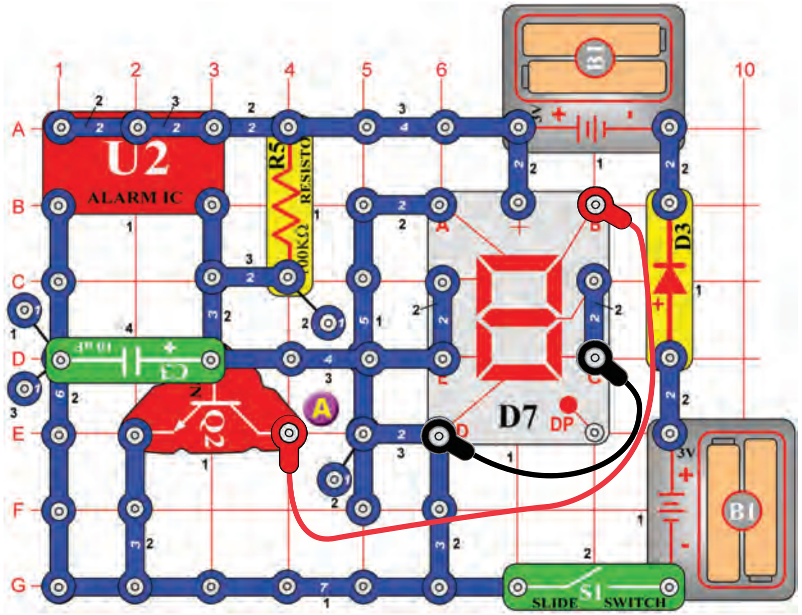
OBJECTIVE: To use the alarm IC to flash between “9” & “0”.



The circuit switches between numbers “9” and “0” on the display.
Place a jumper from point A to segment G and segment B to segment C.

Project #608 — "3" & "6" Blinker

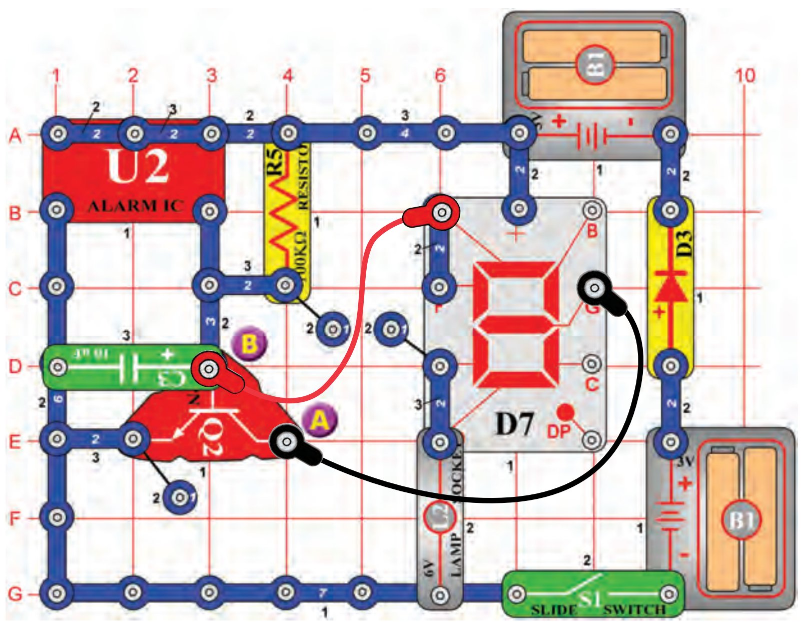
OBJECTIVE: To use the alarm IC to flash between "3" & "6".



The circuit switches between numbers "3" & "6" on the display. Place a jumper from segment C to segment D and segment B to point A.

Project #609 — "c" & "C" Blinker

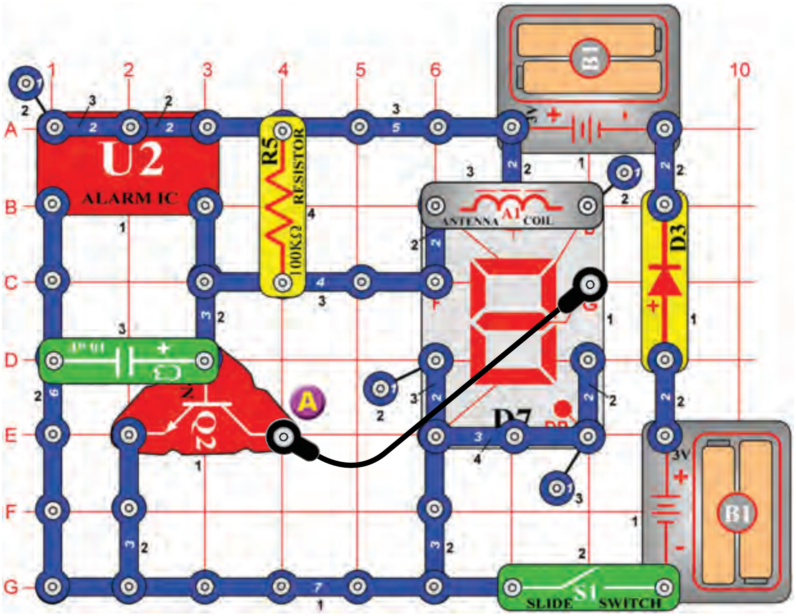
OBJECTIVE: To use the alarm IC to flash between "c" & "C".



The circuit switches between letters "c" & "C" on the display. Place a jumper from point A to segment G and point B to segment A.

☐ Project #610 — "O" & "o" Blinker

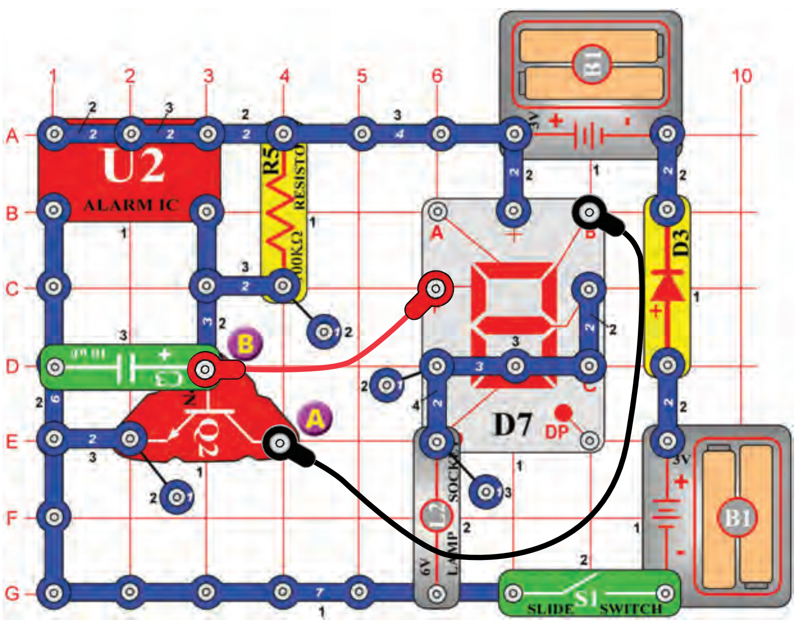
OBJECTIVE: To use the alarm IC to flash between "O" & "o".



The circuit switches between upper case "O" and lower case "o". Place a jumper from point A to segment G. The DP segment will also light.

☐ Project #611 — "b" & "d" Blinker

OBJECTIVE: To use the alarm IC to flash between "b" & "d".

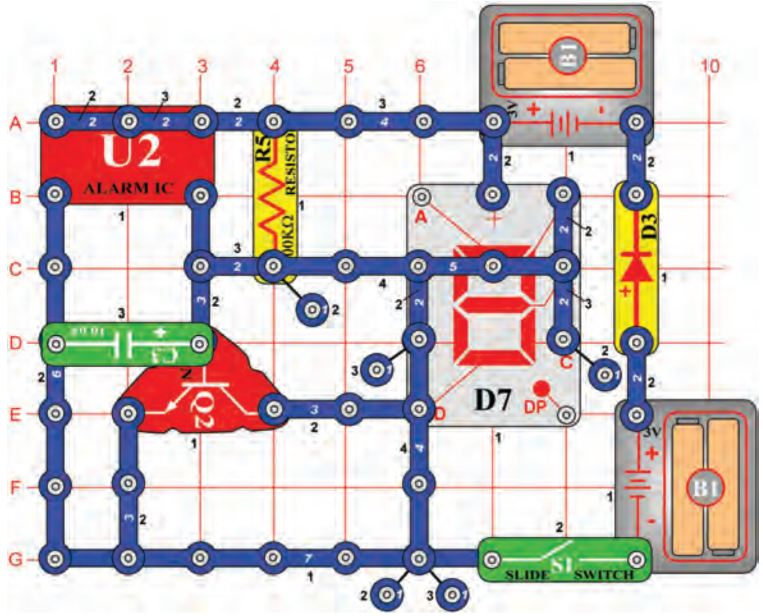


The circuit switches between letters "b" & "d" on the display. Place a jumper from point A to segment B and point B to segment F.

Project #612

"H" & "L" Blinker

OBJECTIVE: To use the alarm IC to flash between "H" & "L".

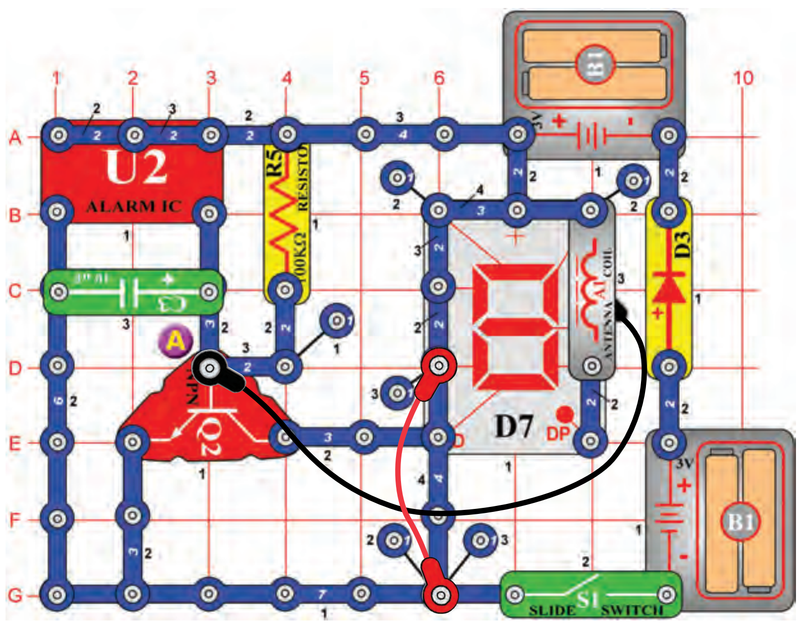


The circuit switches between letters "H" & "L" on the display.

Project #613

"A" & "O" Blinker

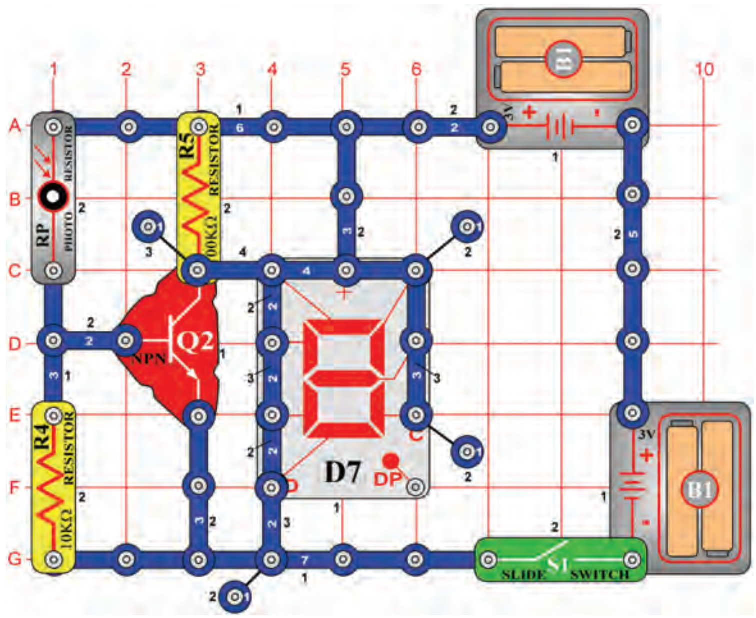
OBJECTIVE: To use the alarm IC to flash between "A" & "O".



The circuit switches between letters "A" & "O" on the display. Place a jumper from point A to segment G. The DP segment will also light.

Project #614 — Open & Closed Indicator

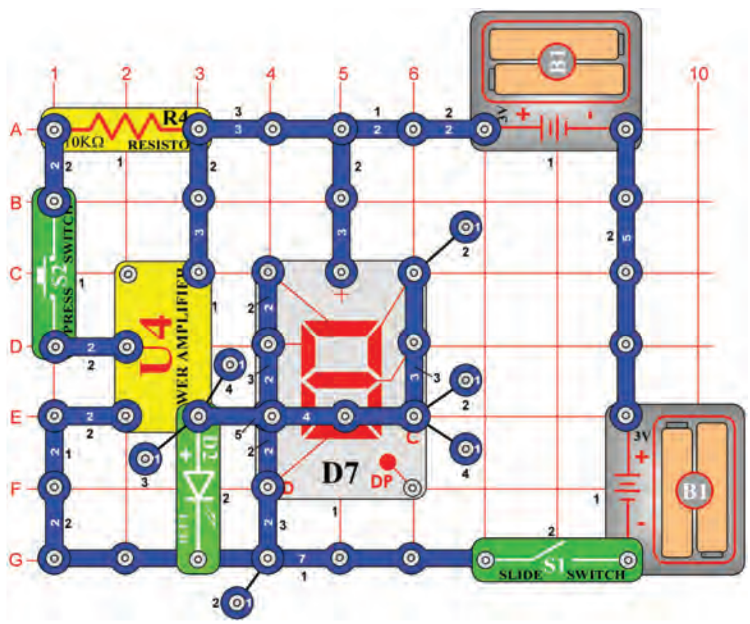
OBJECTIVE: To construct a circuit that indicates if a door is open or closed using light.



Switching from letters “O” to “C” requires turning off segments B & C. Turn on the slide switch (S1), the display lights an “O” indicating an open door. Cover the photoresistor (RP) with your hand (closed door) and the letter “C” lights. The photoresistor turns Q2 on and off depending on the amount of light. When Q2 is on (light on RP) the voltage at the collector is low, lighting segments B & C. Covering the RP turns Q2 off and the collector voltage is high now. Segments B & C turn off and the letter “C” lights.

Project #615 — Open & Closed Indicator (II)

OBJECTIVE: To construct a circuit that indicates if a switch is open or closed using U4.



As in project #614, the display will light an “O” or “C” indicating if the press switch (S2) is on or off. Turn on the slide switch (S1), the LED (D2) and letter “O” lights. With no input to U4 the LED lights and the voltage decreases enough so segments B & C light. Press the press switch S2, the LED turns off and the letter “C” lights. The voltage at U4’s output increased enough turning the segments off.

Project #616 — Vibration Indicator

OBJECTIVE: To construct a circuit that indicates vibration.

Modify project #615 by replacing the press switch (S2) with the whistle chip (WC). As you tap the whistle chip, U4’s output voltage changes, lighting the LED (D2) and changing the display from “C” to “O”.

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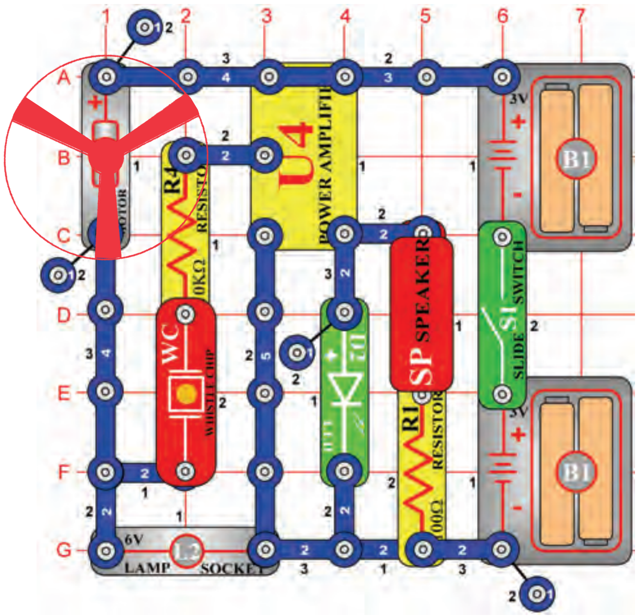
Project #617 — Vibration Sounder

OBJECTIVE: To construct a circuit that indicates vibration.

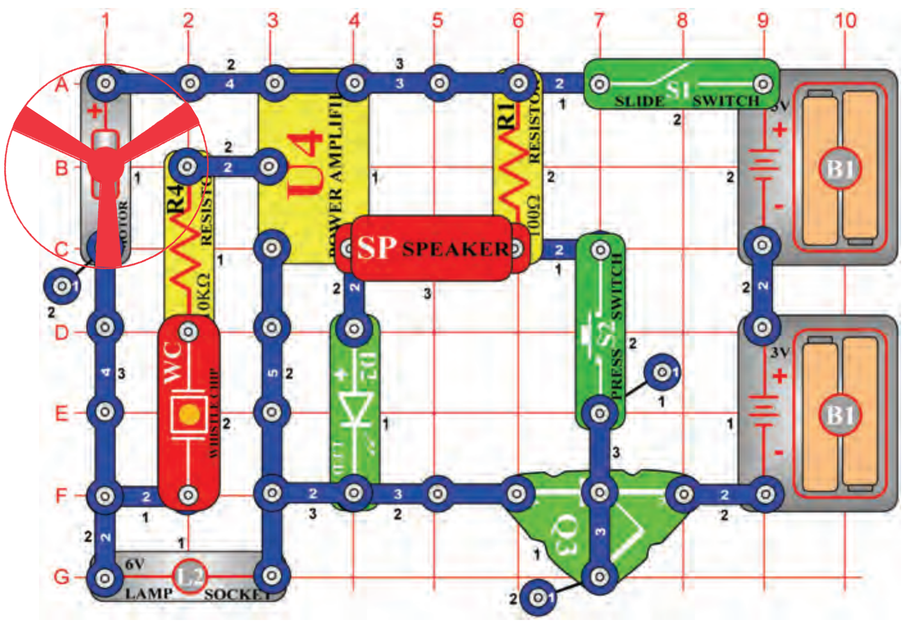


As the motor (M1) spins, it generates an AC voltage amplified by U4. The output from U4 lights the LED (D2) and makes noise from the speaker (SP). With the fan not installed, turn on the slide switch (S1) and you hear the high tone of the spinning motor. Now, install the fan and hear the difference.

WARNING: Moving parts. Do not touch the fan or motor during operation. Do not lean over the motor.

Project #618 — SCR Noise Circuit

OBJECTIVE: To use the SCR to start a circuit.



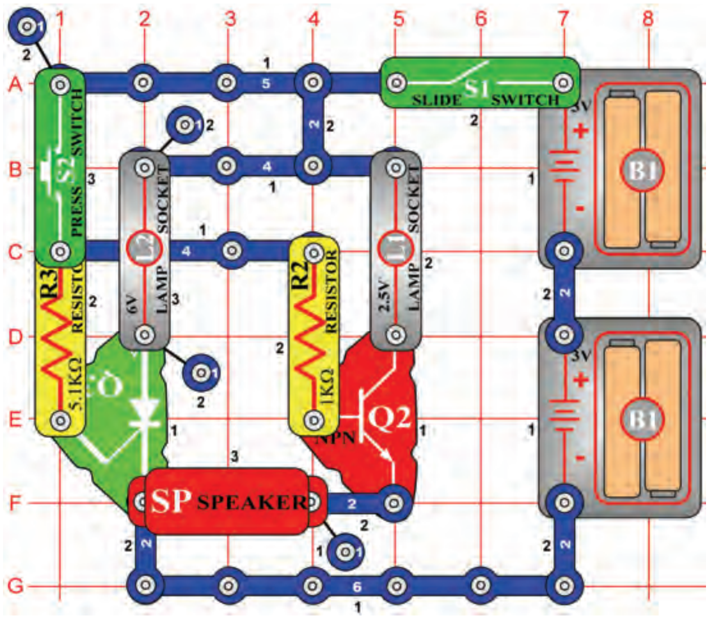
Turn on the slide switch (S1) and nothing happens. The SCR (Q3) connects the circuit to the batteries and, until the SCR's gate goes high, the circuit is off. Press the press switch (S2) and the motor (M1) spins and the LED (D2) and bulb (L2) light. Increase the sound from the speaker (SP) by pressing the press switch.

WARNING: Moving parts. Do not touch the fan or motor during operation. Do not lean over the motor.

Project #619

SCR & Transistor Switch

OBJECTIVE: Control bulbs L1 & L2 with an SCR and transistor.

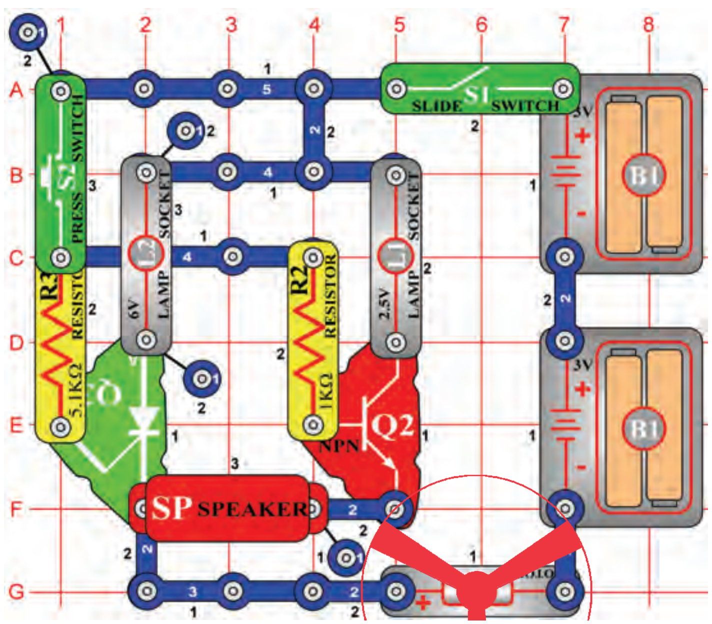


Turn the slide switch (S1) on and then press the press switch (S2), both bulbs (L1 & L2) light, but only L2 stays on when S2 is released. To stay on, the transistor (Q2) requires a continuous voltage but the SCR only needs a pulse. The speaker (SP) may not make any sound.

Project #620

Two-speed Motor

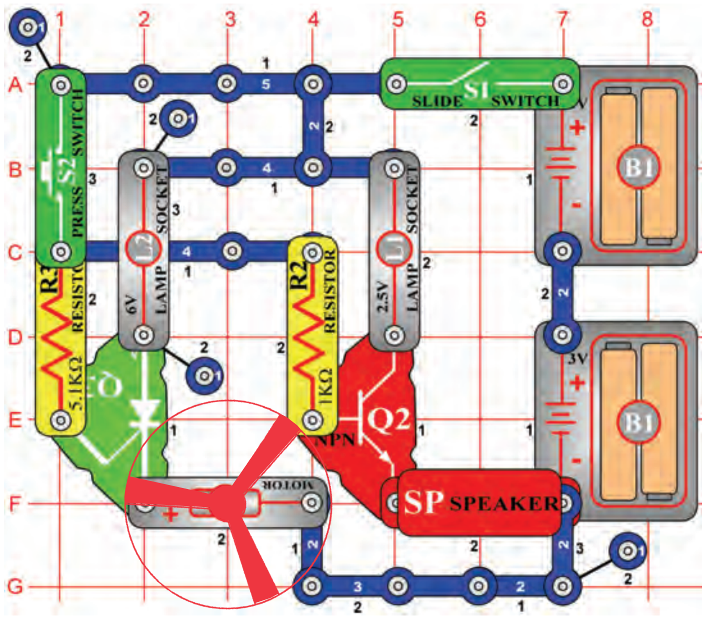
OBJECTIVE: Increase the speed of a motor using an SCR and transistor.



If you turn on either switch (S1 or S2) alone, nothing happens. But if you turn on the slide switch (S1) and then press the press switch (S2), the lamps (L1 & L2) light and the motor (M1) spins. The SCR (Q3) keeps the 6V lamp (L2) on and the motor spinning after you release the press switch. If you hold the press switch down, then the 2.5V lamp (L1) stays on and the motor spins faster.

WARNING: Moving parts. Do not touch the fan or motor during operation. Do not lean over the motor.

Project #621 Two-speed Motor (II)

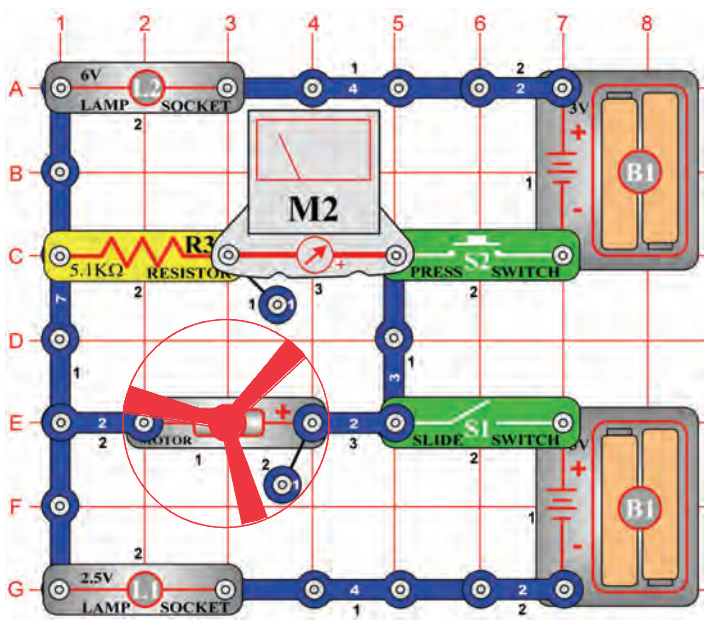


OBJECTIVE: To decrease the speed of a motor using an SCR and transistor.

Instead of increasing the motor's speed as in project #620, pressing the press switch (S2) decreases the speed. In this circuit, the transistor (Q2) is in parallel with the SCR (Q3). Pressing S2 turns on Q2 and the voltage across the motor (M1) decreases.

WARNING: Moving parts. Do not touch the fan or motor during operation. Do not lean over the motor.

Project #622 Current Flow



OBJECTIVE: To show the effects of current flow.

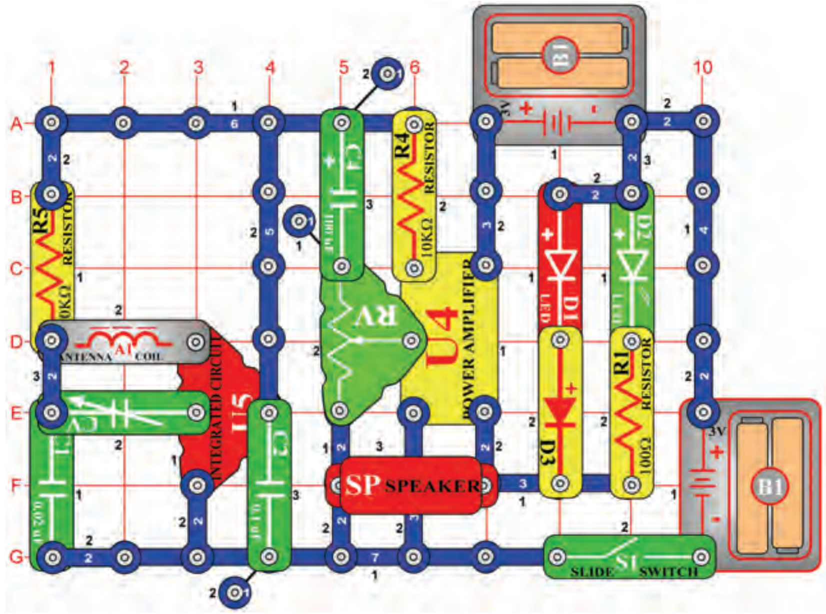
Set the meter (M2) to the LOW (or 10mA) position. Turning on the slide switch (S1) connects the motor (M1), meter and 2.5V lamp (L1) to the lower battery (B1) pack. The motor rotates clockwise and the meter deflects right. Now turn off the slide switch and press the press switch (S2). Now, current from the upper battery causes the motor to rotate in the opposite direction. If you place the batteries in series by turning on the slide switch and then pressing the press switch, only the bulbs (L1 & L2) light.

WARNING: Moving parts. Do not touch the fan or motor during operation. Do not lean over the motor.

Project #623

AM Radio with Power LED's

OBJECTIVE: To build an AM radio with LED's.

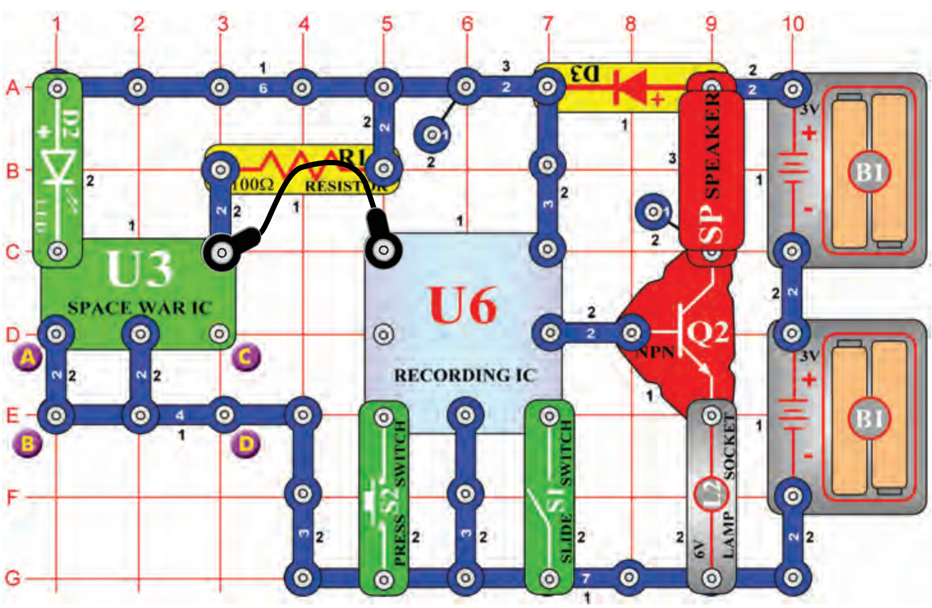


Set the adjustable resistor (RV) to the middle position and turn the slide switch (S1) on. Tune the radio by adjusting the variable capacitor (CV). The LED's (D1 & D2) flicker as the sound is heard.

Project #624

Space War IC Recording

OBJECTIVE: To record the sounds from the space war IC.

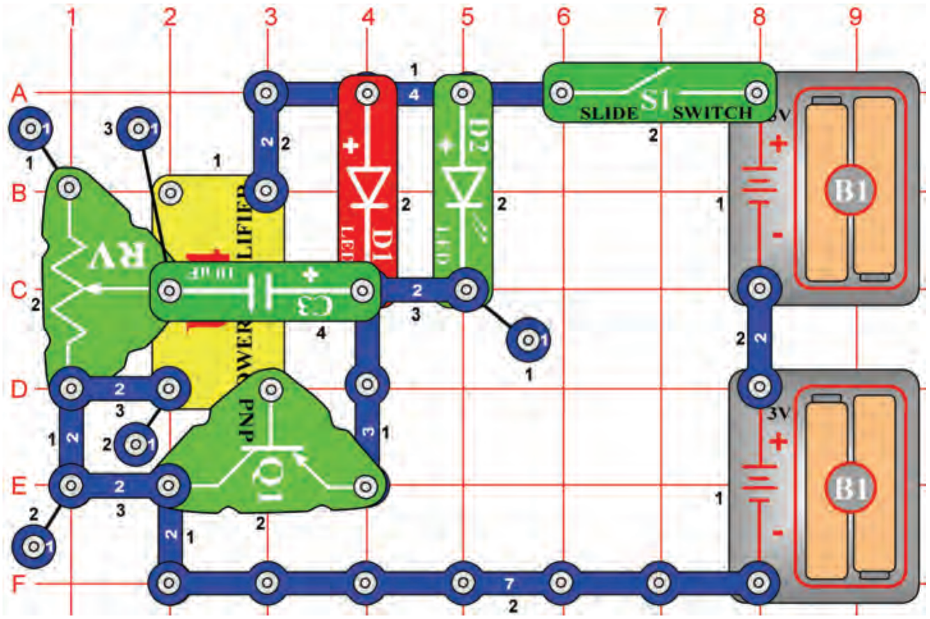


The circuit records the sounds from the space war IC (U3) into the recording IC (U6). Turn on the slide switch (S1) and the first beep indicates that the IC has begun recording. When you hear two beeps, the recording has stopped. Turn off the slide switch and press the press switch (S2). You will hear the recording of the space war IC before each song is played. The lamp (L2) is used to limit current and will not light.

Place the 2-snap from points A & B onto C & D. Now record a different sound from U3.

☐ Project #625 — LED Flasher

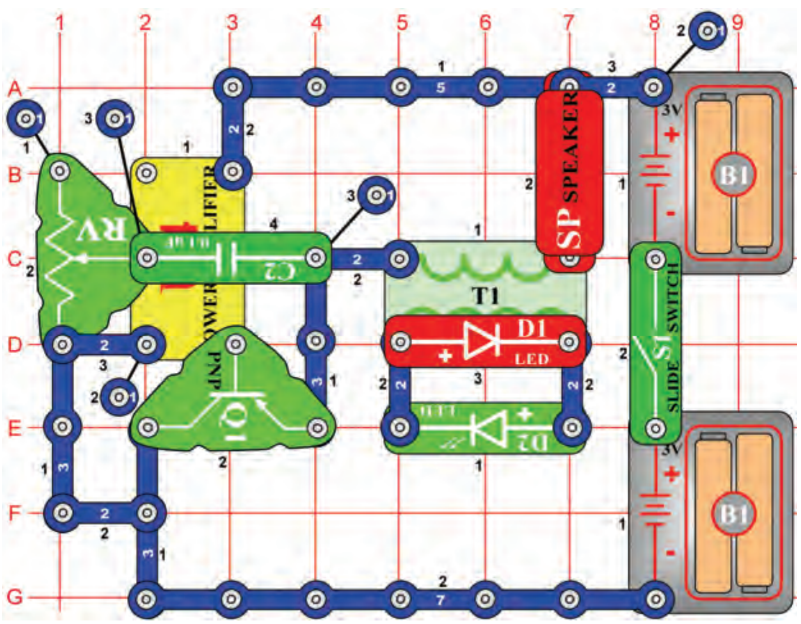
OBJECTIVE: To construct an LED flasher.



Set the adjustable resistor (RV) to the top position and then turn on the slide switch (S1). The LED's (D1 & D2) flash at a rate of once per second. As you adjust RV's knob down, the LED's flash faster. When RV is at the bottom, the LED's turn off.

☐ Project #626 — LED Flasher with Sound

OBJECTIVE: To construct an LED flasher with sound.



You can modify project #625 by adding a transformer (T1) to drive a speaker (SP). Set the adjustable resistor (RV) to the top position and turn on the slide switch (S1). The speaker sounds as the LED (D2) flashes several times per second. Increase the rate by moving RV's knob down.

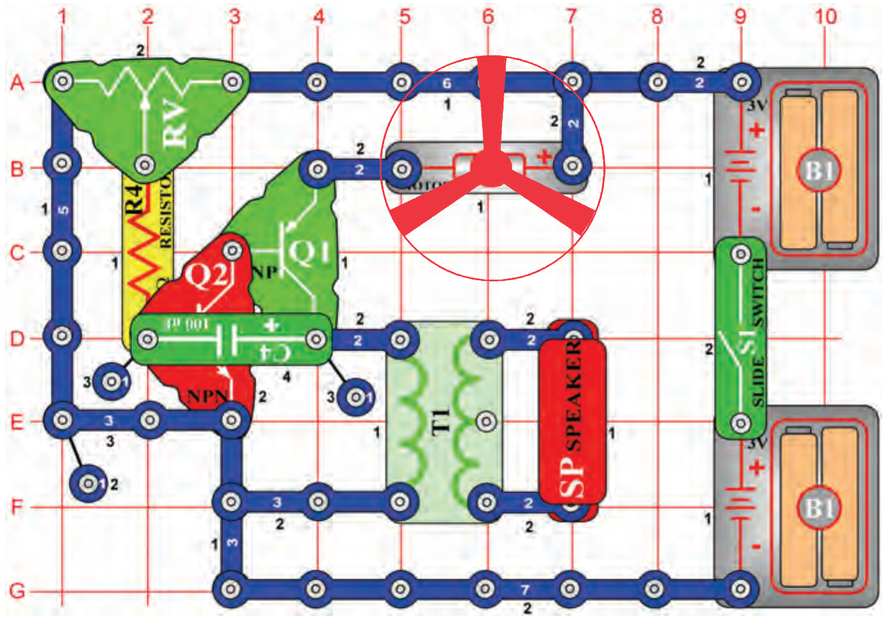
☐ Project #627 — LED Flasher with Sound (II)

OBJECTIVE: To construct an LED flasher with sound.

Modify the frequency by replacing the 0.1μF capacitor (C2) with the 10μF capacitor (C3, "+" side on the right).

☐ Project #628 **Stepper Motor**

OBJECTIVE: To build a variable stepper motor.

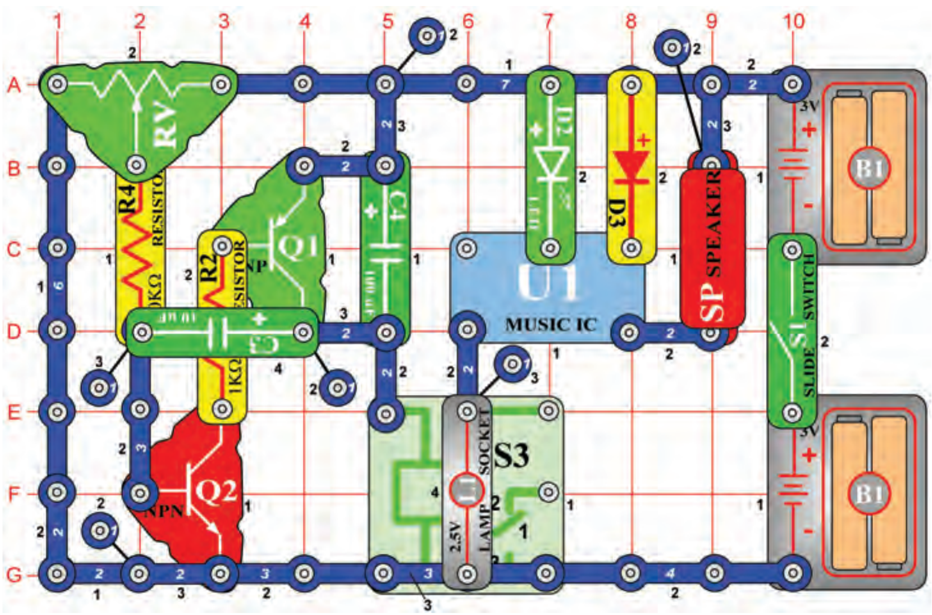


Adjust the adjustable resistor (RV) to the middle position and turn on the slide switch (S1). As the circuit oscillates, the motor (M1) moves a short distance as the speaker (SP) sounds. Adjust the adjustable resistor to different positions seeing how it affects the motor and speaker.

WARNING: Moving parts. Do not touch the fan or motor during operation. Do not lean over the motor.

☐ Project #629 **Crazy Music IC**

OBJECTIVE: To change the sound of the music IC.



Set the adjustable resistor (RV) to the far left position and turn the slide switch (S1) on. The relay's (S3) contacts open and close shorting U1 to ground, causing the sound level to change.

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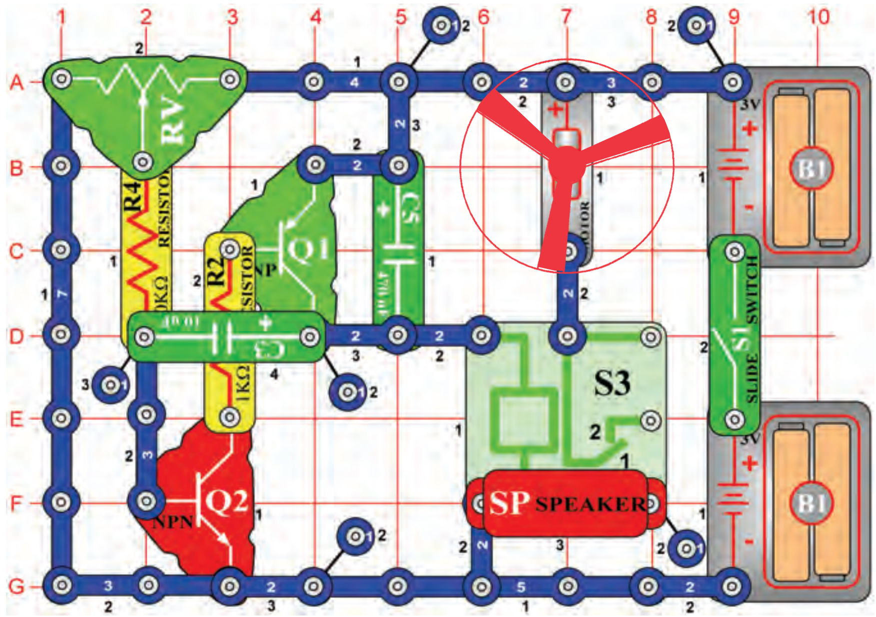
Project #630 Stepper Motor w/ Sound



OBJECTIVE: To add sound to a stepper motor circuit.

Set the adjustable resistor (RV) to the middle position. Turn the slide switch (S1) on and the motor (M1) pulses on and off as the speaker (SP) sounds. As the circuit oscillates, the relay's (S3) contacts open and close shorting the motor and speaker to ground. See how much you can adjust the adjustable resistor before the motor turns off or continuously spins.

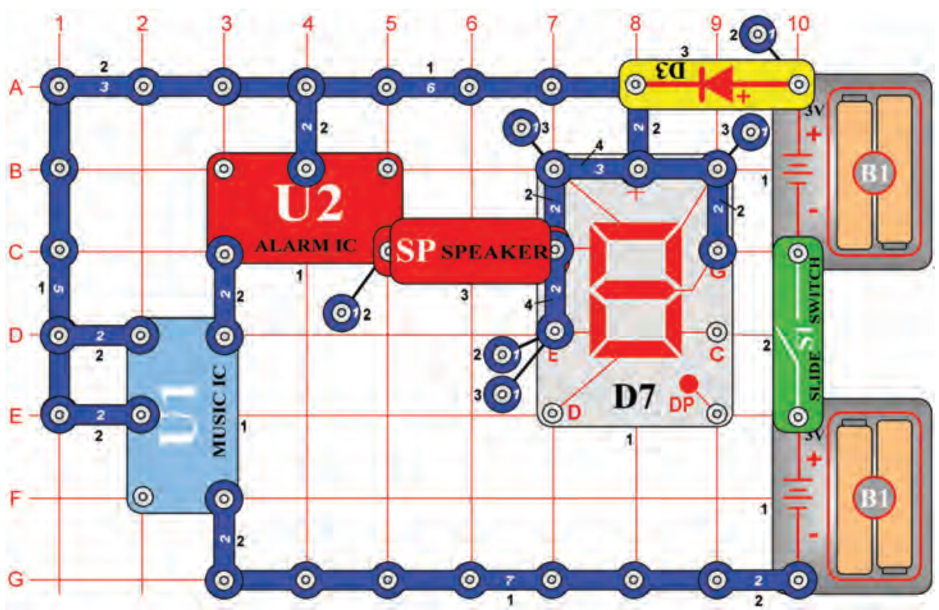
Project #631 Stepper Motor w/ Light

OBJECTIVE: To add light to a stepper motor circuit.

Modify project #630 by removing the speaker (SP) and replacing it with the lamp (L1). Now when you turn the slide switch (S1) on, the lamp lights as the motor spins.

WARNING: Moving parts. Do not touch the fan or motor during operation. Do not lean over the motor.

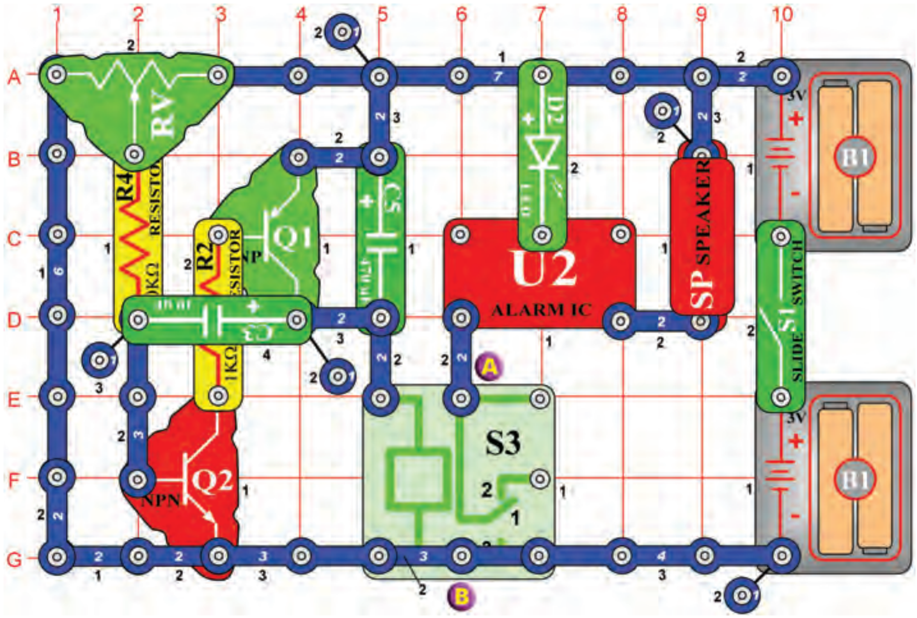
Project #632 Police Siren with Display



OBJECTIVE: To display the letter "P" as the alarm IC sounds.

Turn the slide switch (S1) on and the speaker (SP) sounds as the letter "P" lights. You also hear the music IC (U1) playing in the background. The alarm IC (U2) plays as long as the music IC is on since U2 is connected to U1's output. After 20 seconds, the circuit turns off for 5 seconds and then starts again.

Project #633 Oscillator Alarm



OBJECTIVE: To control the alarm IC with an oscillator circuit.

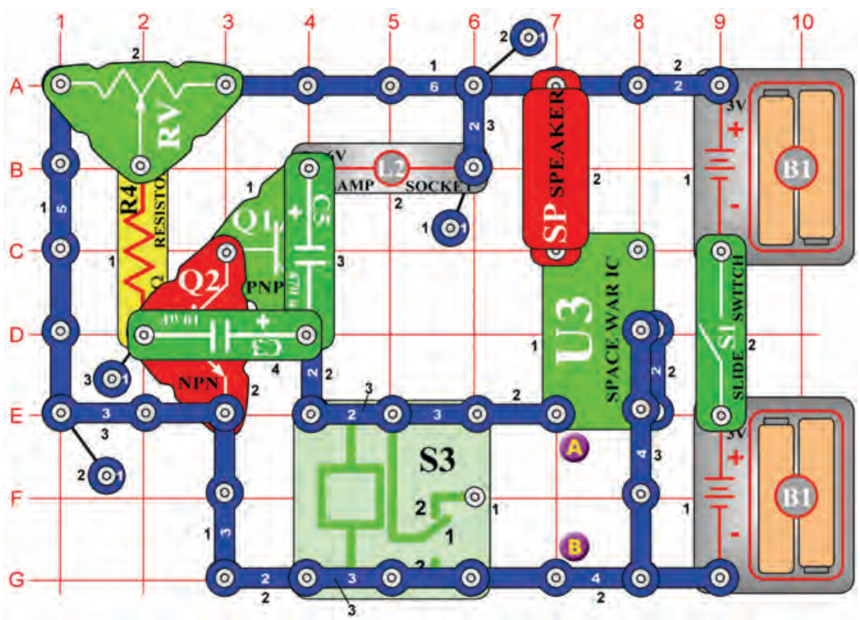
Set the adjustable resistor (RV) to the far left and turn the slide switch (S1) on. The speaker (SP) sounds only once. Slowly move the adjustable resistor to the right, the speaker momentarily sounds. As you move the adjustable resistor to the right, the alarm is on continuously. The adjustable resistor controls the frequency of the oscillator circuit (C3, C5, Q1, Q2) by adjusting the voltage at Q2's base. The relay (S3) switches the alarm IC (U2) on and off.

Project #634 Oscillator Alarm (II)

OBJECTIVE: To control the alarm IC with an oscillator circuit.

Using a single snap, connect the red LED (D1, "+" side on point A) across points A & B. Turn the slide switch (S1) on and the circuit has a different sound now.

Project #635 Tapping U3



OBJECTIVE: To control the space war IC with an oscillator circuit.

Set the adjustable resistor (RV) to the middle position and turn the slide switch (S1) on. This is another example using the oscillator that switches the power on and off creating sound. Alter the sound by adjusting the adjustable resistor.

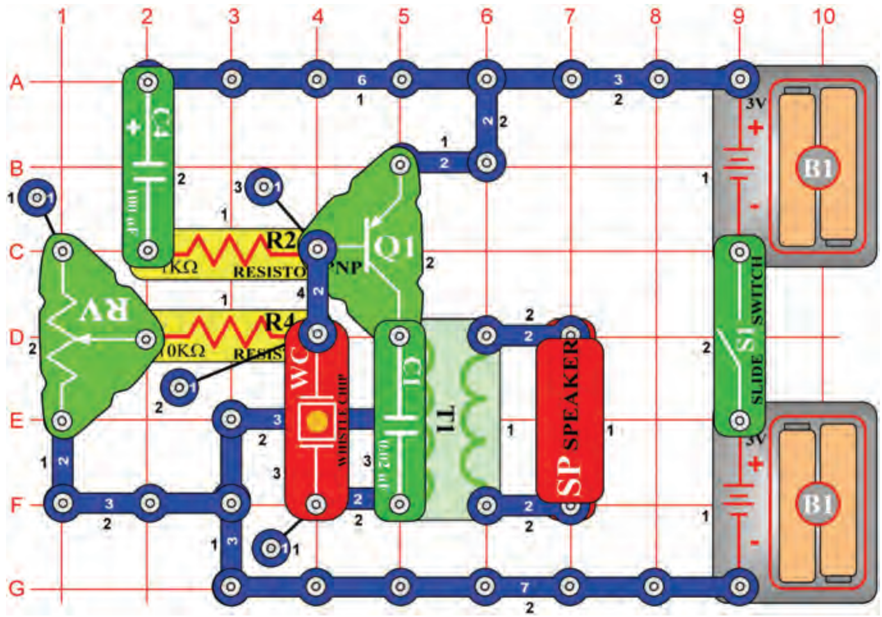
Project #636 Tapping U3 (II)

OBJECTIVE: To control the space war IC with an oscillator circuit.

Connect the motor (M1) across points A & B. Set the adjustable resistor (RV) to the middle position and turn the slide switch (S1) on. Now you hear random noise and static from the speaker (SP). The motor causes the random static and noise from the speaker.

Project #637 Adjustable Beeper

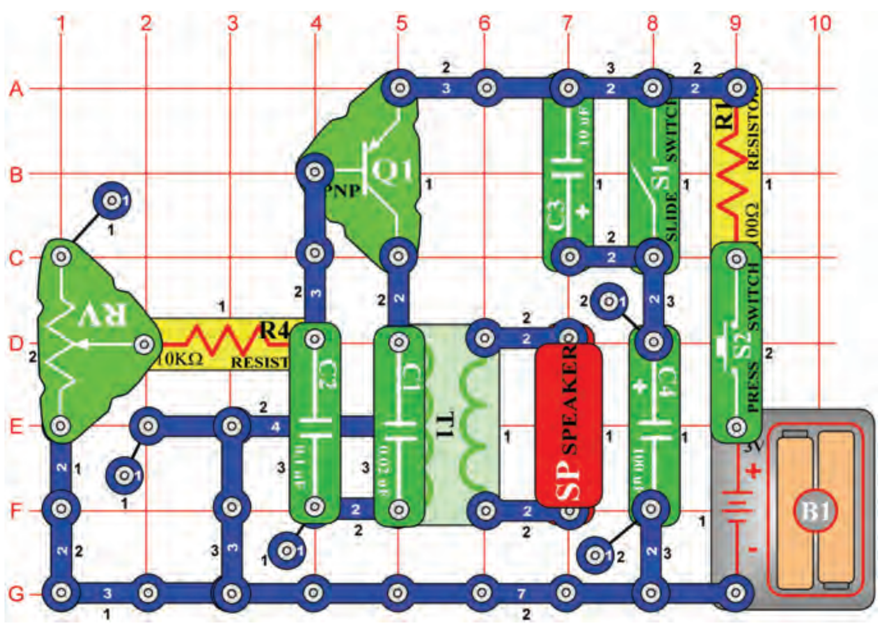
OBJECTIVE: To build a simple oscillator that beeps.



Turn the slide switch (S1) on and this simple oscillator circuit outputs a beep from the speaker (SP). Change the frequency by adjusting the adjustable resistor (RV).

Project #638 Electronic Meow

OBJECTIVE: To create the sound of a cat's meow.



Turn off the slide switch (S1) and then press and release the press switch (S2). You hear a "cat's meow" from the speaker (SP). Now turn the slide switch (S1) on and the sound is lower and lasts longer. Adjust the adjustable resistor (RV) while the sound is fading away.

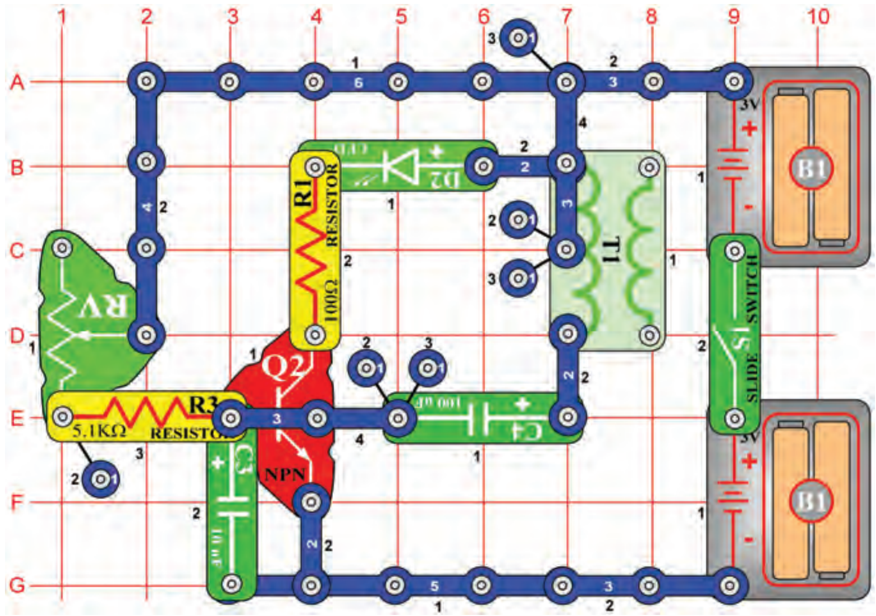
Project #639 Electronic Meow (II)

OBJECTIVE: To add the photoresistor to project #638.

Replace the 10KΩ resistor (R4) with the photoresistor (RP). Wave your hand over photoresistor as you press down on the press switch (S2).

Project #640 Strobe Light

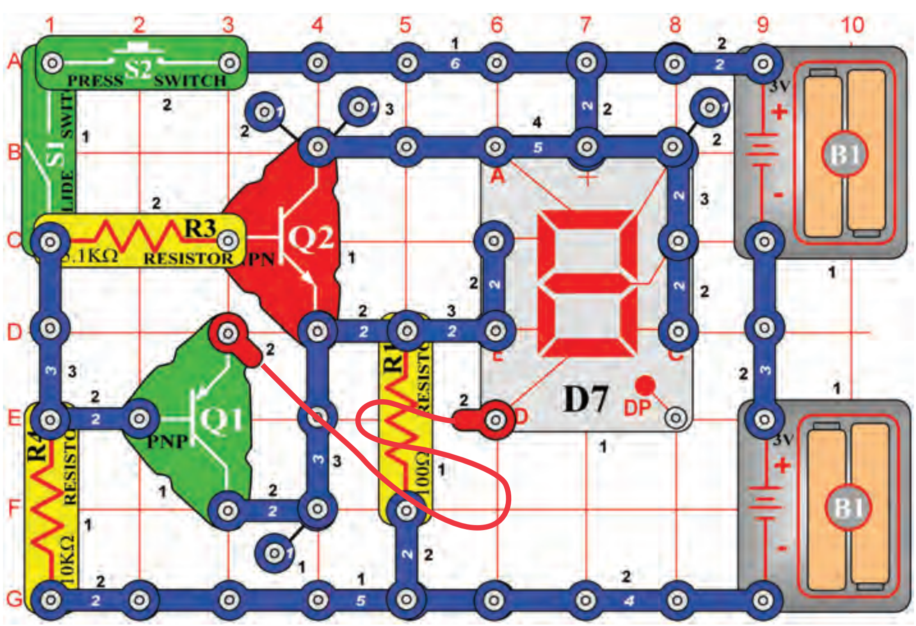
OBJECTIVE: To construct an LED strobe light.



This is an example of how a large strobe light works. Turn the slide switch (S1) on and the LED (D2) flashes at a certain frequency. Adjust the frequency by adjusting the adjustable resistor (RV). Now add sound by replacing the 100Ω resistor (R1) with the speaker (SP). Each time the LED lights, the speaker sounds.

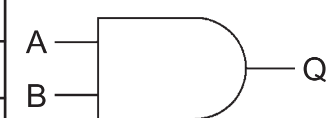
Project #641 AND Gate

OBJECTIVE: To demonstrate the operations of the AND gate.



In digital electronics, there are two states, 0 & 1. The **AND gate** performs a logical "and" operation on two inputs, A & B. If A **AND** B are both 1, then Q should be 1. The logic table below shows the state of "Q" with different inputs and the symbol for it in circuit diagrams.

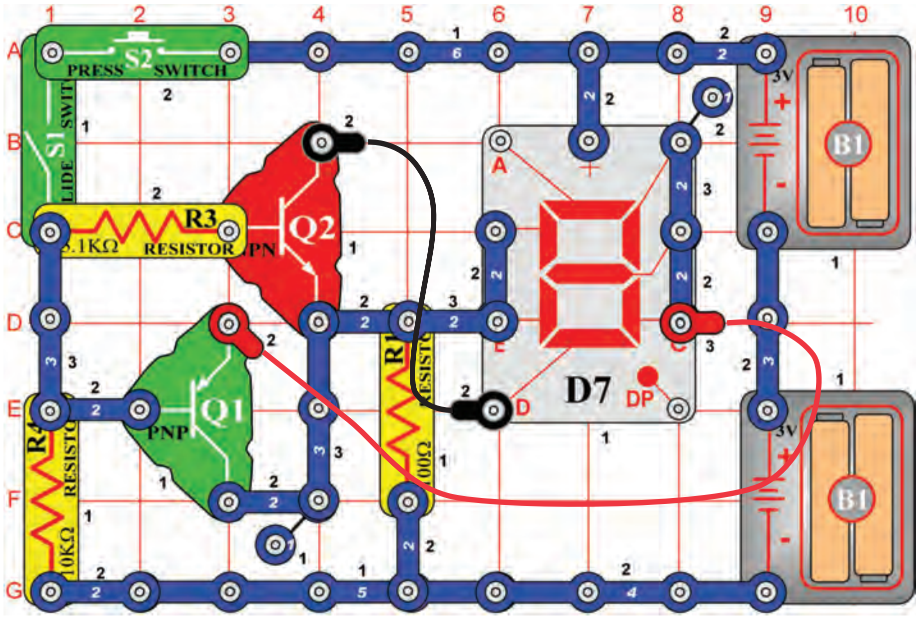
A	B	Q	D7
0	0	0	"L"
1	0	0	"L"
0	1	0	"L"
1	1	1	"H"



AND Gate

In the circuit, the S1 & S2 switches represent inputs A & B, and the D7 display represents output Q.

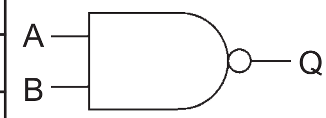
Project #642 NAND Gate



OBJECTIVE: To demonstrate the operations of the NAND gate.

The NAND gate works the opposite of the AND as shown in the logic chart.

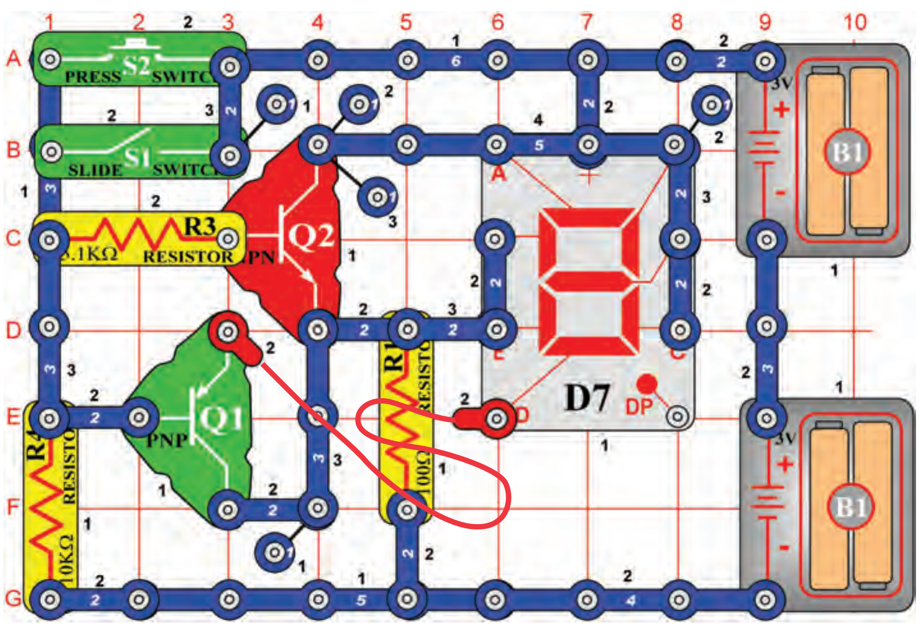
A	B	Q	D7
0	0	1	“H”
1	0	1	“H”
0	1	1	“H”
1	1	0	“L”



NAND Gate

In the circuit, the S1 & S2 switches represent inputs A & B, and the D7 display represents output Q.

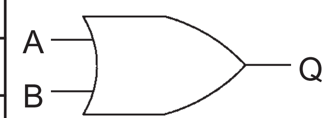
Project #643 OR Gate



OBJECTIVE: To demonstrate the operations of the OR gate.

The basic idea of an OR gate is: If A OR B is 1 (or both are 1), then Q is 1.

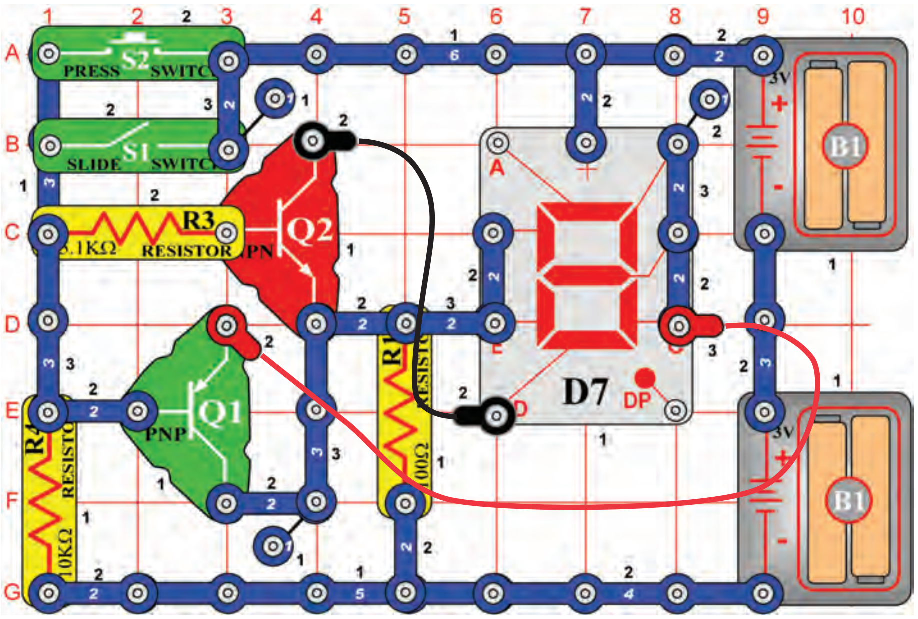
A	B	Q	D7
0	0	0	“L”
1	0	1	“H”
0	1	1	“H”
1	1	1	“H”



OR Gate

In the circuit, the S1 & S2 switches represent inputs A & B, and the D7 display represents output Q.

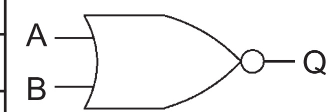
Project #644 NOR Gate



OBJECTIVE: To demonstrate the operations of the NOR gate.

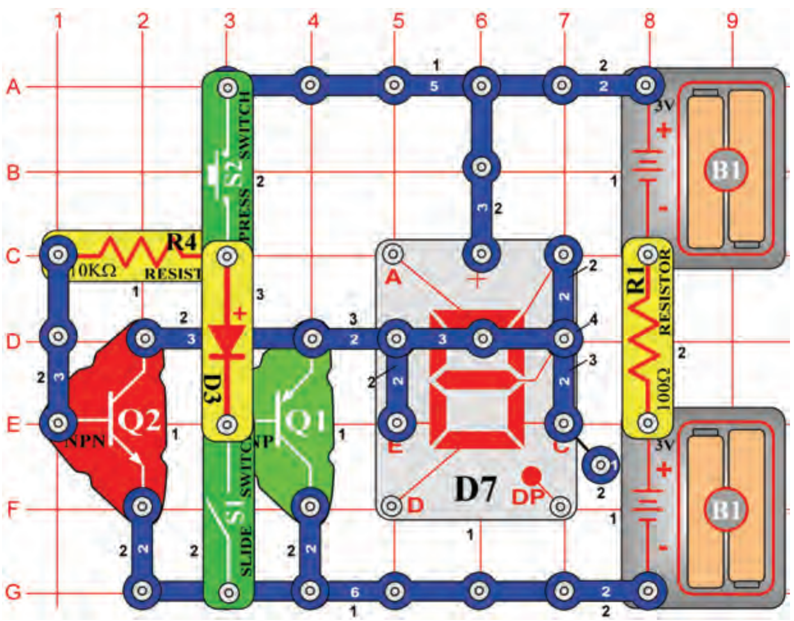
The NOR gate works the opposite of the OR. In the circuit, the S1 & S2 switches represent inputs A & B, and the D7 display represents output Q.

A	B	Q	D7
0	0	1	“H”
1	0	0	“L”
0	1	0	“L”
1	1	0	“L”



NOR Gate

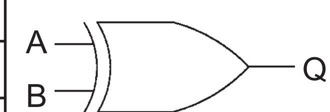
Project #645 XOR Gate



OBJECTIVE: To demonstrate the operations of the “exclusive or” XOR gate.

In an XOR gate the output “Q” is only high when inputs “A” or “B” is set high (1).
Using the chart, set the switches (S1 & S2) to the different states. The display (D7) lights the letter “H” only when either switch is turned on.

A	B	Q	D7
0	0	0	–
1	0	1	“H”
0	1	1	“H”
1	1	0	–



XOR Gate

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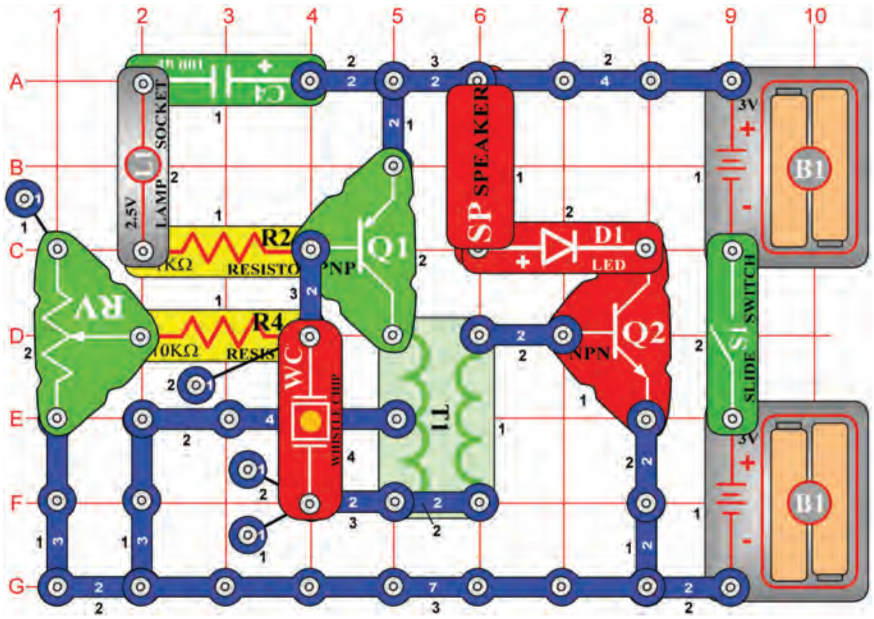
☐ Project #646 High Pitch Oscillator



OBJECTIVE: To build a high pitch oscillator.

Set the adjustable resistor (RV) to the top position and then turn the slide switch (S1) on. You hear a high pitch sound and the LED (D1) flashes at the same rate. Change the oscillator frequency by adjusting RV.

☐ Project #647 Low Pitch Oscillator

OBJECTIVE: To modify project #646.

Replace the whistle chip (WC) with the 0.1μF capacitor (C2). Turn the slide switch (S1) on and now the circuit oscillates at a lower frequency.

☐ Project #648 Low Pitch Oscillator (II)

OBJECTIVE: To modify project #646.

Replace the 0.1μF capacitor (C2) with the 10μF capacitor (C3) placing the "+" sign towards the top. Turn the slide switch (S1) on; now the circuit oscillates at a lower frequency.

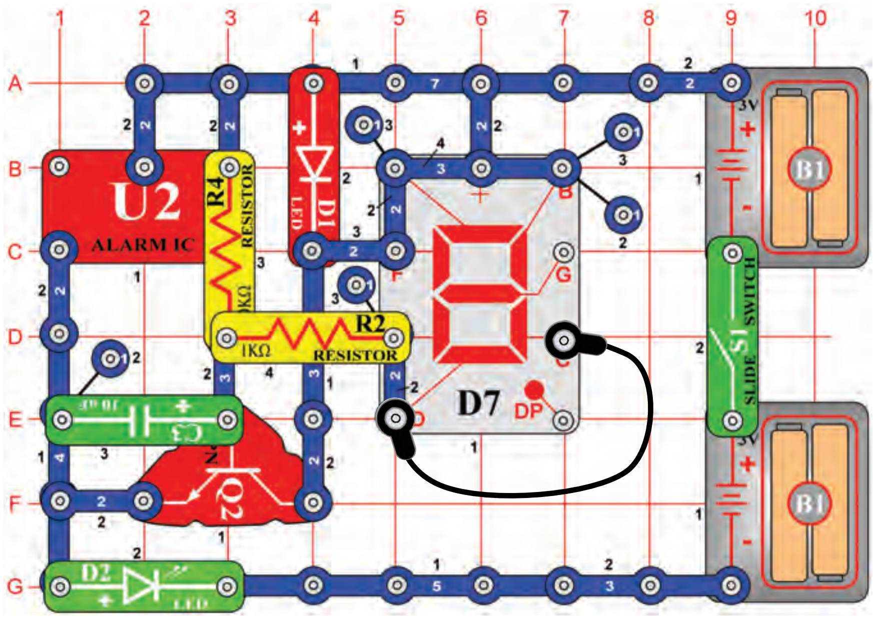
☐ Project #649 Low Pitch Oscillator (III)

OBJECTIVE: To modify project #646.

Replace the 10μF capacitor (C3) with the 470μF capacitor (C5) placing the "+" sign towards the top. Turn the slide switch (S1) on and the circuit oscillates at a lower frequency now.

Project #650 Segment Jumper

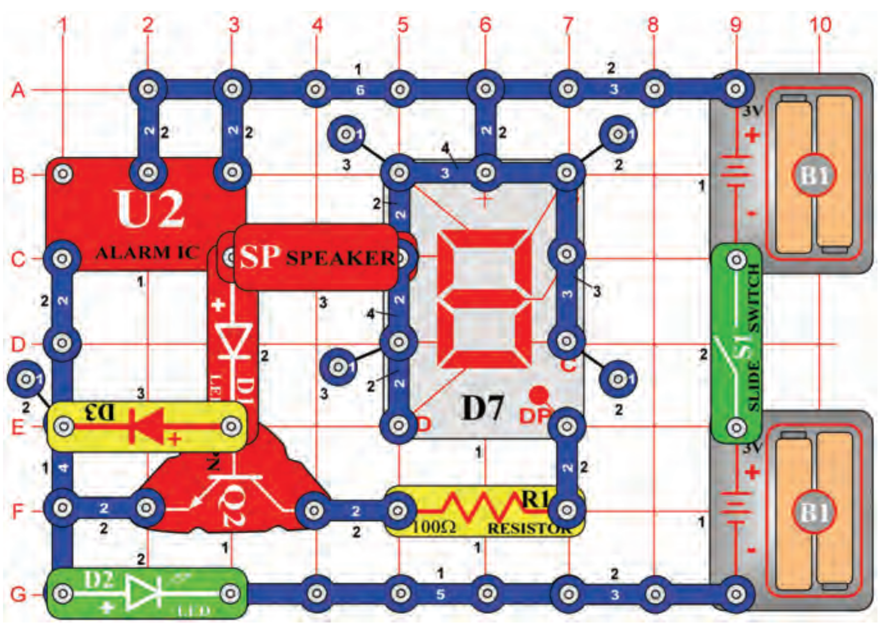
OBJECTIVE: To use the alarm IC with the 7-segment display.



Turn the slide switch (S1) on; segments A, B, and F light and then segments C, D, and E. The two groups of segments are connected to different voltages. As the voltage changes from high to low, the segments toggle back and forth.

Project #651 DP & Zero Flasher

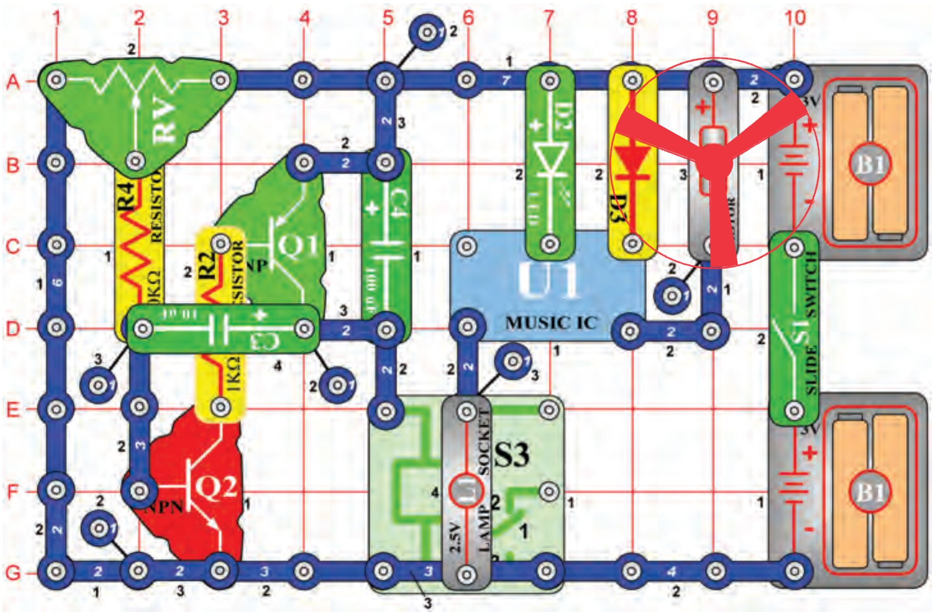
OBJECTIVE: To use the alarm IC with the 7-segment display.



As in project #650, we use the alarm IC (U2) to flash segments and LED's. Turn the slide switch (S1) on and the number "0" and the green LED (D2) flash as the speaker (SP) sounds. When they turn off, the DP segment lights.

Project #652

Stepper Motor with Lamp & LED’s



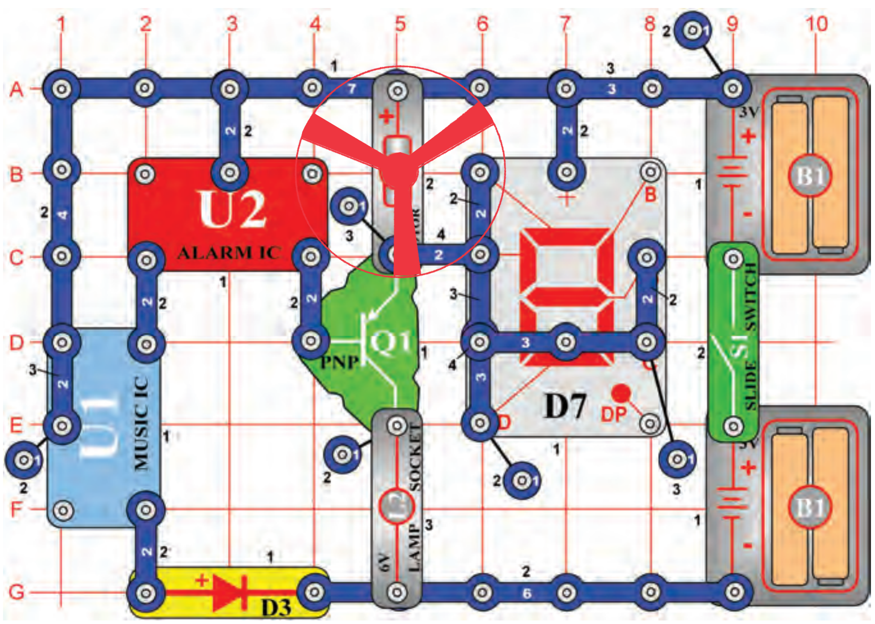
OBJECTIVE: To add LED’s to a stepper motor circuit.

Set the adjustable resistor (RV) to the middle position. Turn the slide switch (S1) on, the motor spins, the bulb lights, and then turn off as the green LED lights.

WARNING: Moving parts. Do not touch the fan or motor during operation. Do not lean over the motor.

Project #653

IC Start & Stop



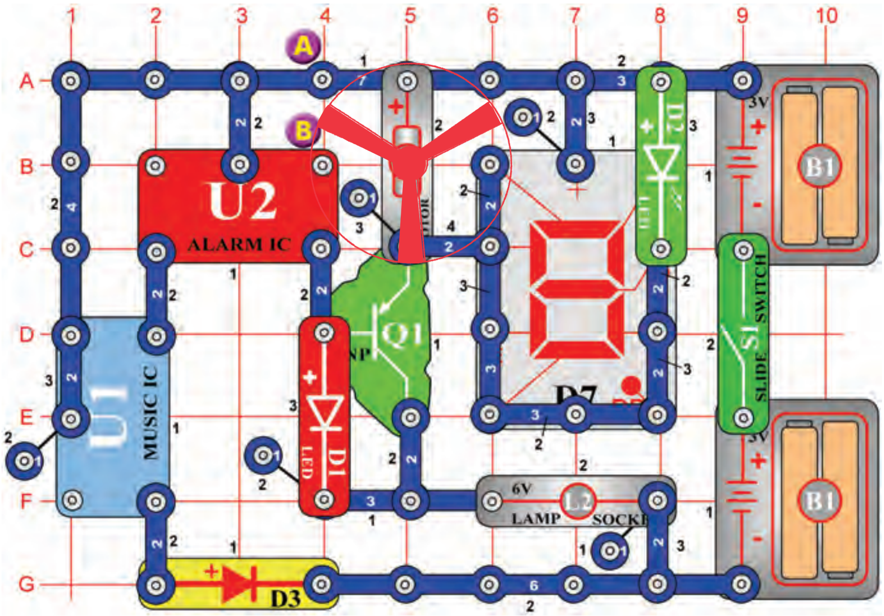
OBJECTIVE: To drive the motor and display with two IC modules.

Turn the slide switch (S1) on. As the output from the IC (U2) drives the transistor (Q1), the motor (M1) spins and the display (D7) lights the letter “S” and then turns off.

WARNING: Moving parts. Do not touch the fan or motor during operation. Do not lean over the motor.

☐ # Project #654 IC Motor Speed

OBJECTIVE: To modify project #653 so the motor slows down.



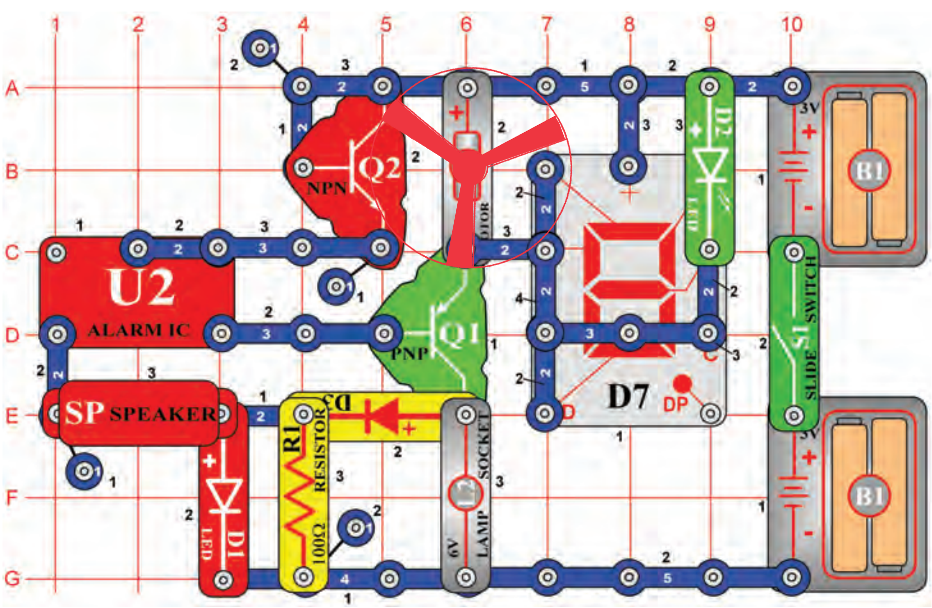
Turn the slide switch (S1) on. As the output from the IC (U2) drives the transistor (Q1), the motor (M1) spins and the display (D7) lights. Instead of turning off as in project #653, the motor slows down and the red LED (D1) lights.

Modify the circuit by placing a jumper wire across points A & B. Now the circuit pulses and then runs continuously for a short time.

WARNING: Moving parts. Do not touch the fan or motor during operation. Do not lean over the motor.

☐ # Project #655 Sound & Light Flasher

OBJECTIVE: To use the alarm IC to drive the motor, speaker, LED and bulb.



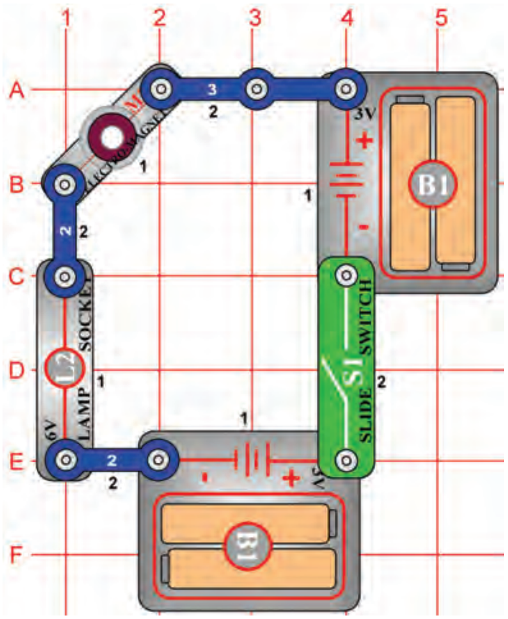
Turn the slide switch (S1) on and the speaker (SP) outputs the sounds from the alarm IC (U2). The IC also drives the transistor (Q1) causing the motor (M1) to spin and lights to flash.

WARNING: Moving parts. Do not touch the fan or motor during operation. Do not lean over the motor.

Project #656

Electromagnet Delayer

OBJECTIVE: To learn about the electromagnet.



Build the circuit and turn it on. After a delay of about 2 seconds, the lamp (L2) will light, but be dim. Replace your batteries if it does not light at all.

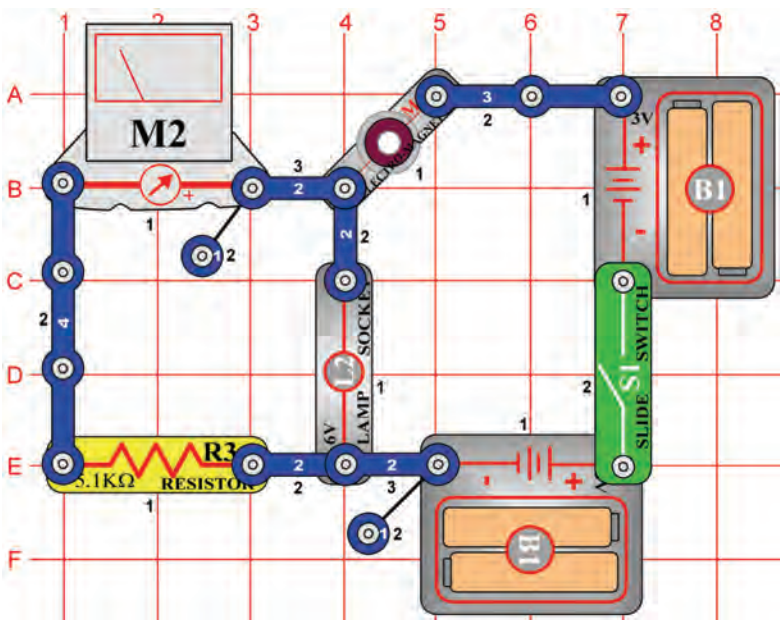
Why does the electromagnet (M3) delay the lamp turn-on? The electromagnet (M3) contains a large coil of wire, and the batteries have to fill the coil with electricity before the lamp can turn on. This is like using a long hose to water your garden - when you turn on the water it takes a few seconds before water comes out the other end.

Once the lamp is on, the resistance of the wire in the coil keeps the lamp from getting bright. You can replace the 6V lamp with the 2.5V lamp (L1), because the coil will protect it from the full battery voltage.

Project #657

Electromagnet Delayer (II)

OBJECTIVE: To learn about the electromagnet.

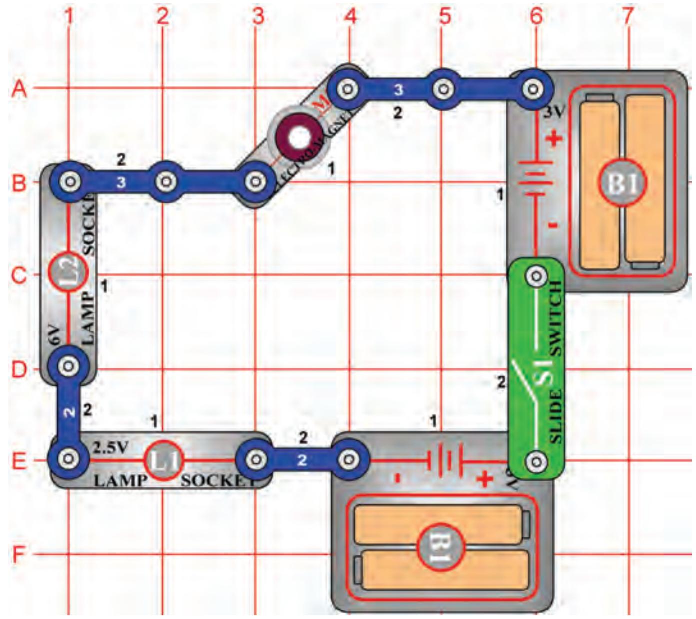


Use the LOW (or 10mA) setting on the meter (M2) and turn on the slide switch (S1). The meter shows how the current slowly rises. After a delay of about 2 seconds, the lamp (L2) will light but be dim.

☐ Project #658

Two-Lamp Electromagnet Delayer

OBJECTIVE: To learn about the electromagnet.



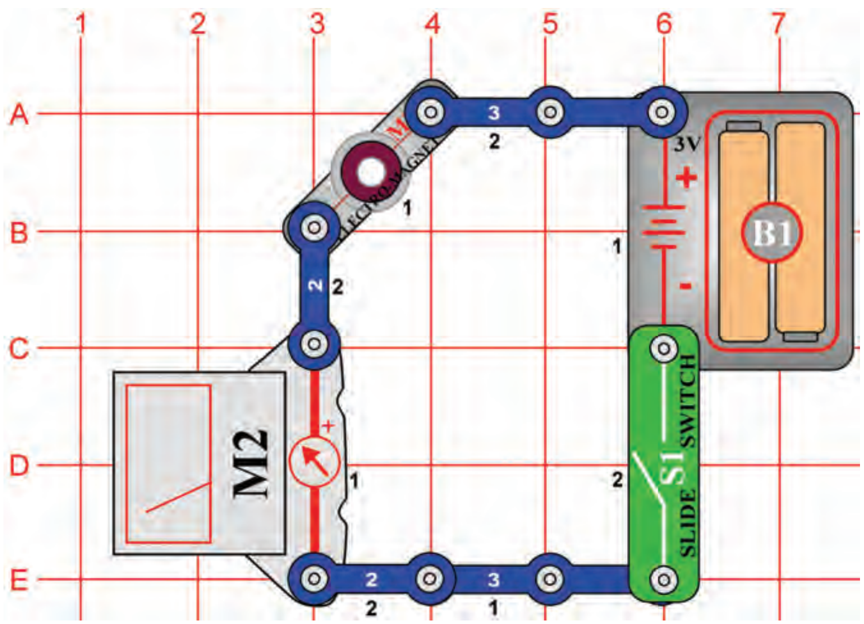
Build the circuit and turn it on. First the 2.5V lamp (L1) turns on, and then the 6V lamp (L2) turns on. Both may be dim, replace your batteries if they do not light at all.

The electromagnet (M3) stores energy, and the batteries must fill it up before the lamps become bright. The smaller bulb turns on sooner because it needs less current to light.

☐ Project #659

Electromagnet Current

OBJECTIVE: To measure the electromagnet current.



Use the HIGH (or 1A) setting on the meter (M2) to measure the electromagnet (M3) current. Compare the meter reading to that for the motor and lamp current in projects #544-546. Insert the iron core rod into the electromagnet and see if it changes the meter reading.

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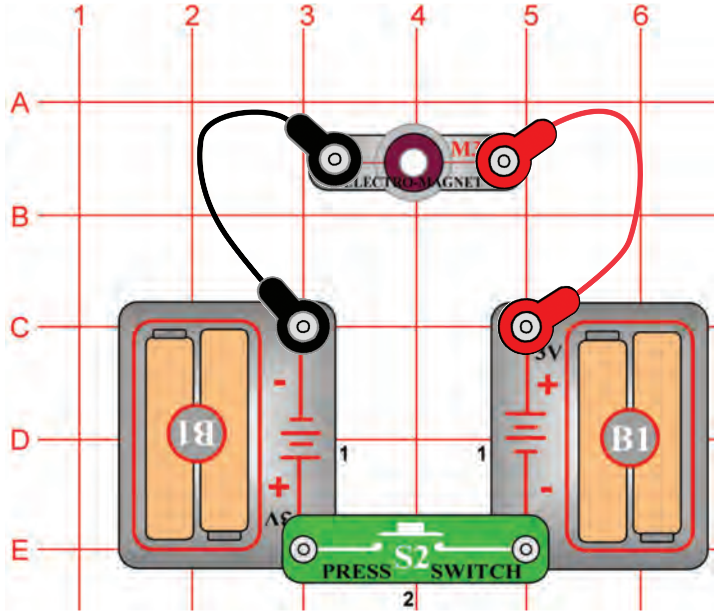
Project #660 Electromagnetism



OBJECTIVE: To learn how electricity and magnetism are related.

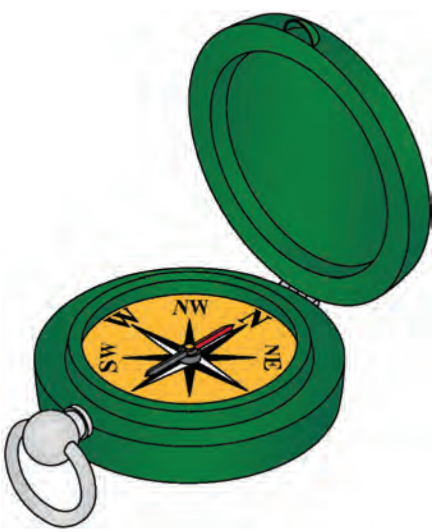
Put the iron core rod into the electromagnet (M3). Press the press switch (S2) and place the electromagnet (M3) near some iron objects like a refrigerator or a hammer, it will be attracted to them. You can use it to pick up iron objects, such as nails.

Electricity and magnetism are closely related, and an electric current flowing in a coil of wire has a magnetic field just like a normal magnet. Placing an iron rod through the coil magnifies this magnetic field. Notice that when the electromagnet is attracted to an iron object, its attraction is strongest at the ends of the iron core rod. If you remove the iron core rod from the electromagnet then its magnetic properties are greatly reduced – try this:

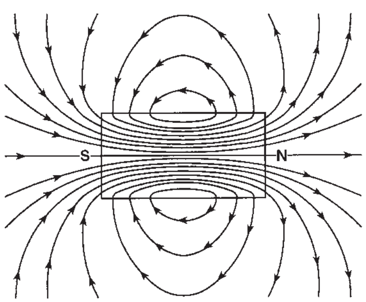
If you place the electromagnet upside down under a large object like a table, you can suspend it there. Be careful though, since it will fall when you release the press switch.

You can use this circuit to see which things are made of iron. Other metals like copper or aluminum will not be attracted to the electromagnet.

Project #661 Electromagnetism & Compass



Compass



Magnetic Field

OBJECTIVE: To learn how electricity and magnetism are related.

You need a compass for this project (not included). Use the circuit from project #660, with the iron core rod in the electromagnet (M3). You may want to use the slide switch (S1) in place of the press switch (S2), but only turn it on as needed or you will quickly drain your batteries.

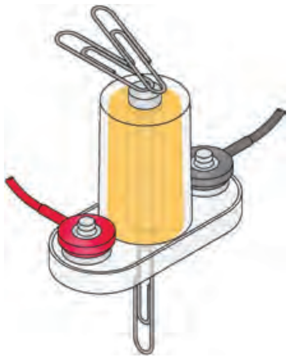
Turn on the slide switch and move the compass around near the edges of the electromagnet, it will point toward ends of the iron core rod. By slowly moving the compass around the electromagnet, you can see the flow of its magnetic field.

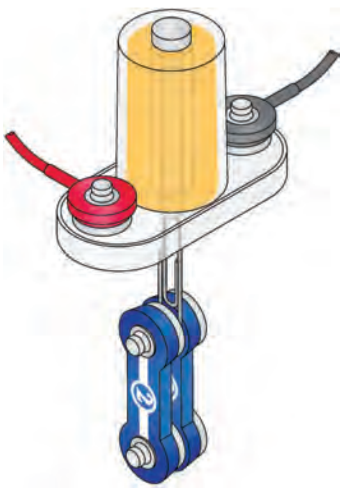
The earth has a similar magnetic field, due to its iron core. A compass points north because it is attracted to this magnetic field. The electromagnet creates its own magnetic field, and attracts the compass in a similar way.

Project #662 Electromagnetism & Paperclips

OBJECTIVE: To learn how electricity and magnetism are related.

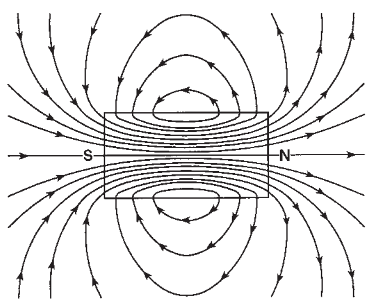
Use the circuit from project #660, with the iron core rod in the electromagnet (M3). Press the press switch (S2) and use the electromagnet to pick up some paperclips, they will be attracted to both ends of the iron core rod. See how many paperclips you can lift at once.

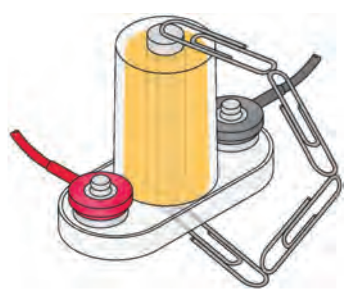




Snap two 2-snaps around a paperclip and lift them with the electromagnet, as shown here on the left.

The magnetic field created by the electromagnet occurs in a loop, and is strongest in the iron core rod in the middle. You can see this loop with some paperclips:



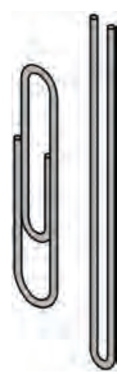


You can also use the paperclip to lift the iron core rod up from the electromagnet.

See what other small objects you can pick up. You can only pick up things made of iron, not just any metal.

Project #663 Electromagnet Suction

OBJECTIVE: To show how electricity can lift things using magnetism.



An electric current flowing in a coil of wire has a magnetic field, which tries to suck iron objects into its center. You can see this using the circuit from project #660.

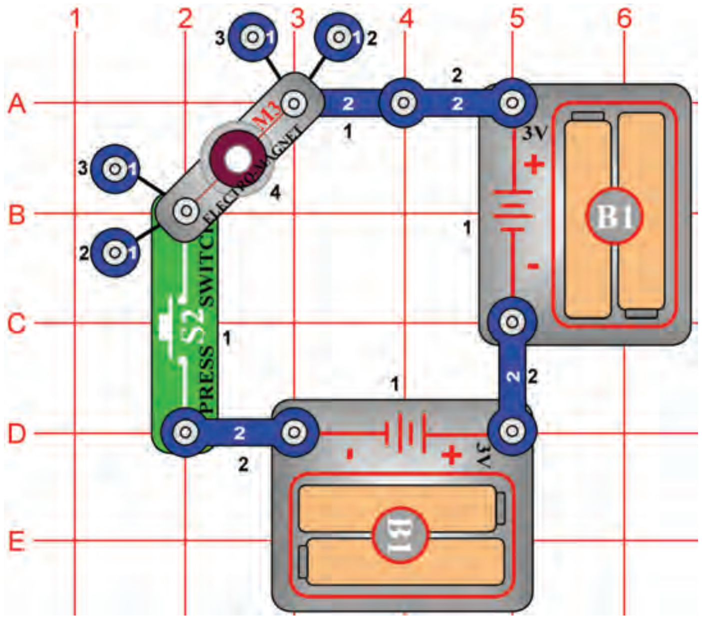
Lay the electromagnet (M3) on its side with the iron core rod sticking out about half way, and press the press switch (S2). The iron rod gets sucked into the center.

A lighter iron object will show this better. Take a paperclip and straighten it out, then bend it in half.

Place the bent paperclip next to the electromagnet and turn on the switch to see it get sucked in. Gently pull it out to feel how much suction the electromagnet has.

Try sucking up other thin iron objects, like nails.

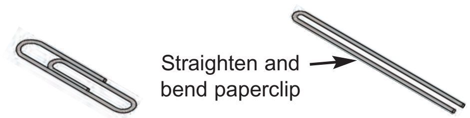
Project #664 Electromagnet Tower

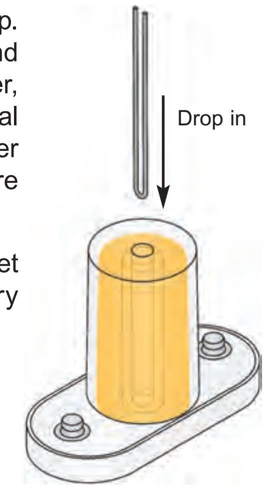


OBJECTIVE: To show how electricity can lift things using magnetism.

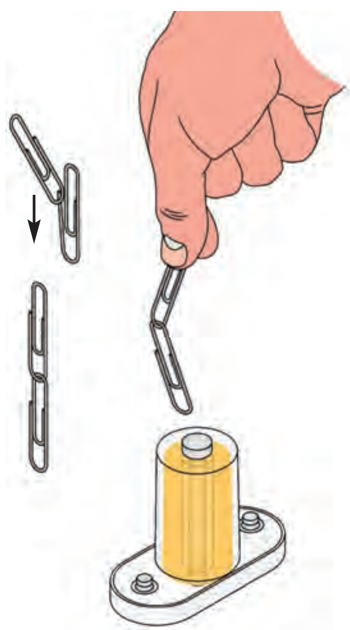
This circuit gives a dramatic demonstration of how the electromagnet (M3) can suck up a paperclip. Take a paperclip and straighten it out, then bend it in half. Drop it into the electromagnet center, and then press the press switch (S2) several times. The paperclip gets sucked into the center of the electromagnet and stays suspended there until you release the press switch.

Add two more 1-snaps under the electromagnet to make it higher, and try this again. Then try sucking up other thin iron objects, like nails.





Project #665 Paperclip Compass



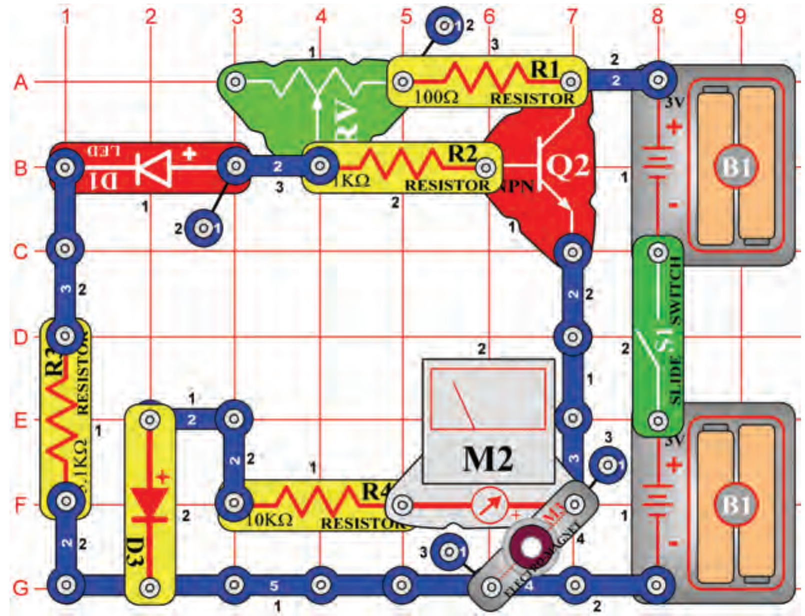
OBJECTIVE: To learn how electricity and magnetism are related.

Use the circuit from project #664, but place the iron core rod in the electromagnet (M3). You may want to use the slide switch (S1) in place of the press switch (S2), but only turn it on as needed or you will quickly drain your batteries.

Slide two paperclips together, using their loops.

Turn on the switch and hold the paperclips just above the electromagnet, without them touching the iron core rod. Watch how the lower paperclip is drawn toward the iron core rod, and will point towards it just like a compass.

Project #666 Adjustable Paperclip Suspension

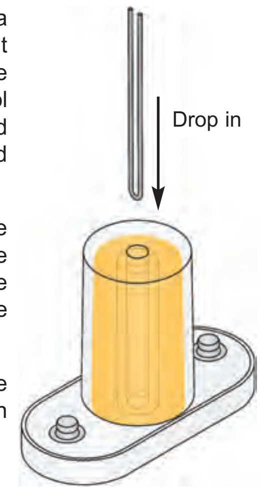


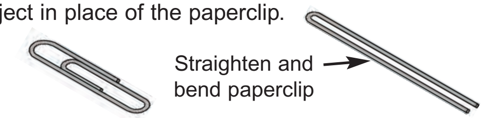
OBJECTIVE: To show how electricity can lift things using magnetism.

Use the LOW (or 10mA) setting on the meter (M2). Take a paperclip and straighten it out, bend it in half, and drop it into the electromagnet (M3) center. Turn on the slide switch (S1) and set the adjustable resistor (RV) control lever all the way to the right. The paperclip gets sucked into the center of the electromagnet and stays suspended there.

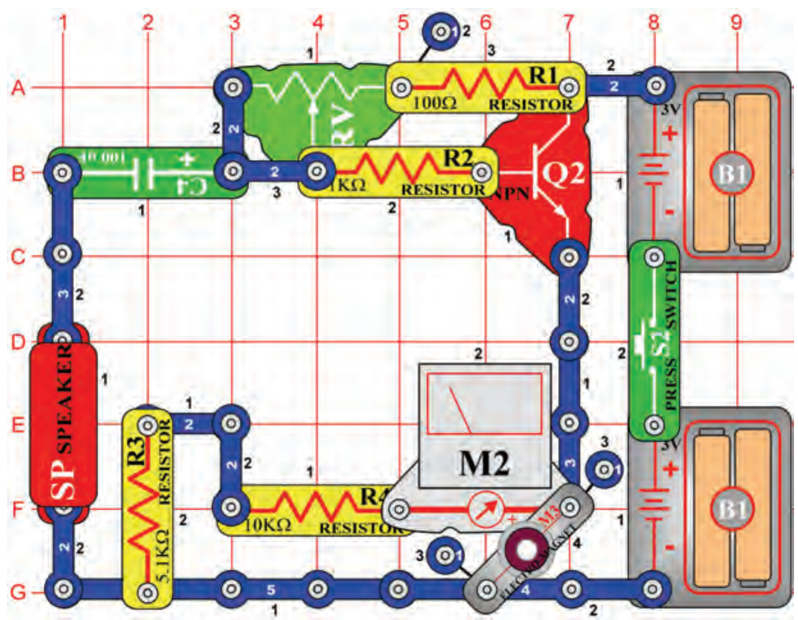
Now very slowly move the adjustable resistor lever to the left, and watch the paperclip and the meter reading. The paperclip slowly gets lower, as the meter shows the current dropping. When the current is at zero, the paperclip is resting on the table.

Add two more 1-snaps under the electromagnet to make it higher, and try this again. Or try using a different iron object in place of the paperclip.





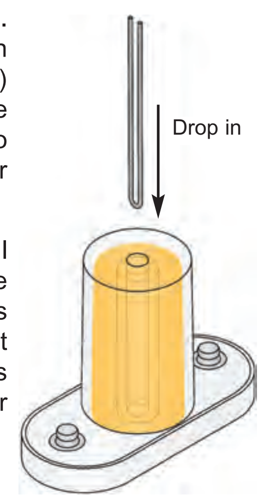
Project #667 Adjustable Paperclip w/ Delay

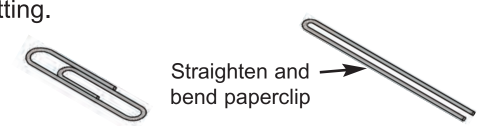


OBJECTIVE: To show how electricity can lift things using magnetism.

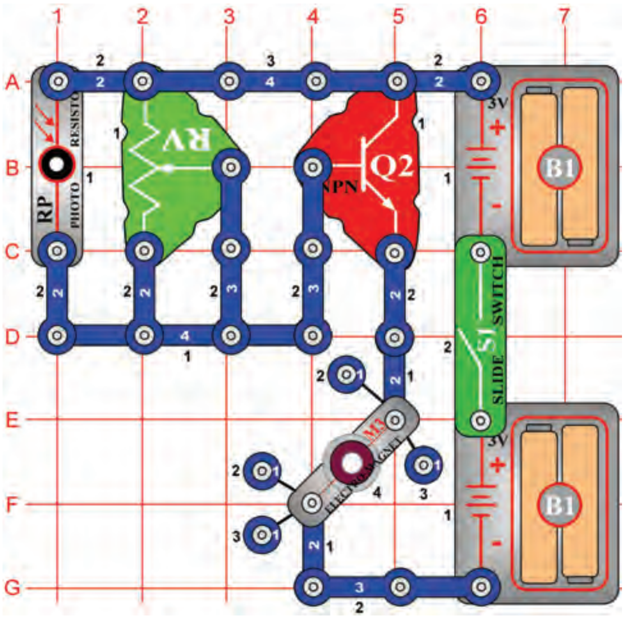
Use the LOW (or 10mA) setting on the meter (M2). Take a paperclip and straighten it out, bend it in half, and place it into the electromagnet (M3) center. Turn on the press switch (S2) and set the adjustable resistor (RV) control lever all the way to the right. The paperclip gets sucked into the center of the electromagnet and stays suspended there.

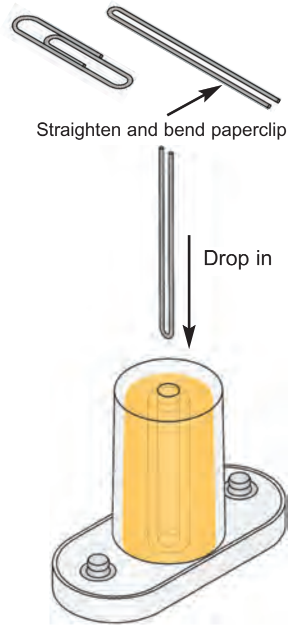
Now quickly slide the adjustable resistor lever all the way to the left, and watch the paperclip and the meter reading. The paperclip slowly gets lower, as the meter shows the current dropping. This circuit is similar to project #666, but the capacitor delays the effect of changing the adjustable resistor setting.





Project #668 Photoresistor Paperclip Suspension



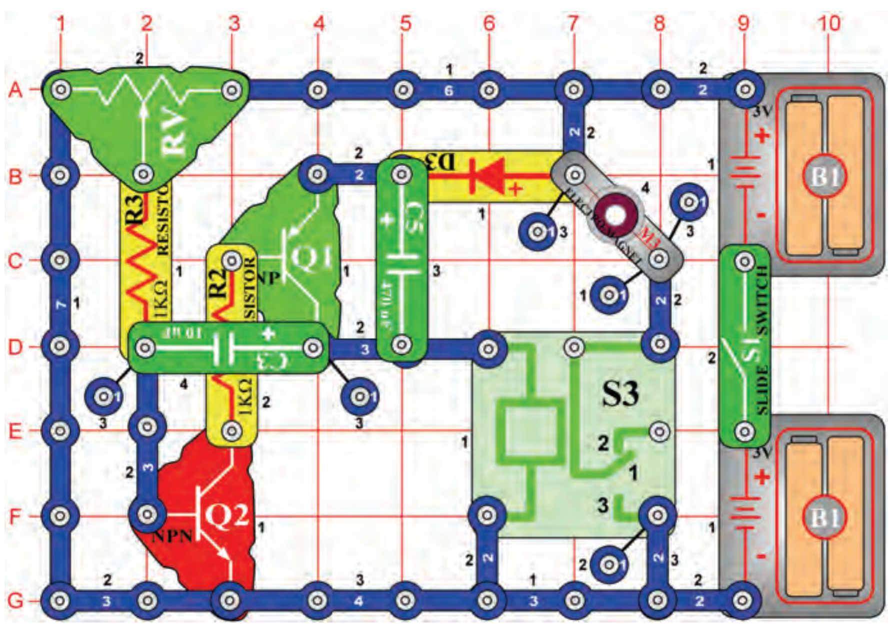


***OBJECTIVE:** To show how electricity can lift things using magnetism.*

Take a paperclip and straighten it out, bend it in half, and place it into the electromagnet (M3) center. Turn on the slide switch (S1), the paperclip gets sucked into the center of the electromagnet and stays suspended there.

Now move the adjustable resistor (RV) control lever around while waving your hand over the photoresistor (RP). Depending on the adjustable resistor setting, sometimes covering the photoresistor causes the paperclip to fall and sometimes it doesn't. You can also adjust the light to set the paperclip to different heights.

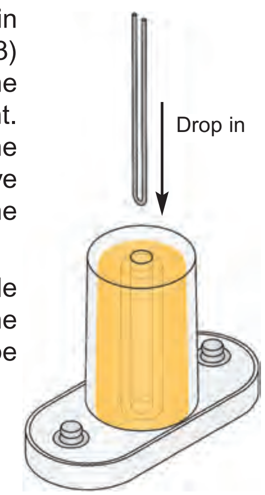
Project #669 Paperclip Oscillator

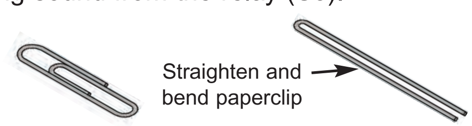


***OBJECTIVE:** To show how electricity can lift things using magnetism.*

Take a paperclip and straighten it out, bend it in half, and place it into the electromagnet (M3) center. Turn on the slide switch (S1), and set the adjustable resistor (RV) control lever to the right. The paperclip gets sucked into the center of the electromagnet and stays suspended there. Move the adjustable resistor lever to the left, and the paperclip falls.

Now for the fun part: Slowly slide the adjustable resistor lever until you find a spot where the paperclip is bouncing up and down. There will be a clicking sound from the relay (S3).

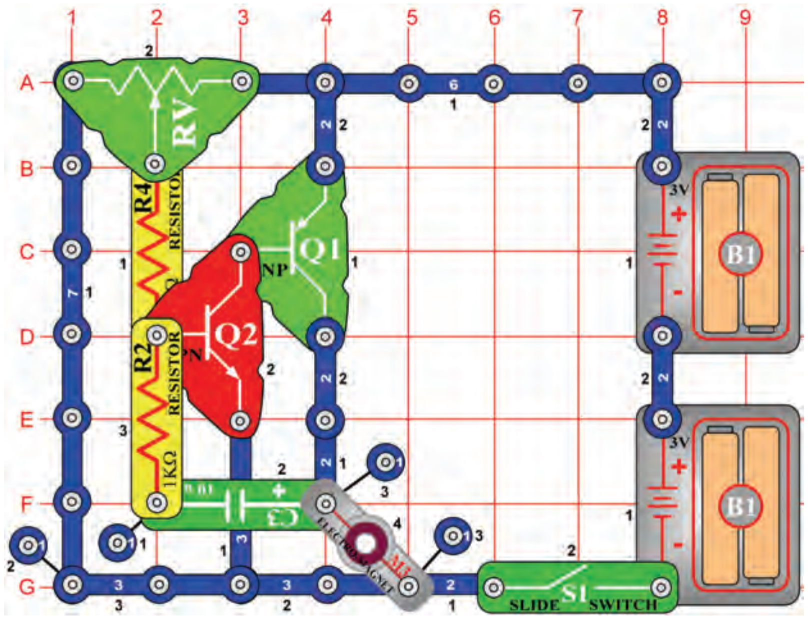




Project #670

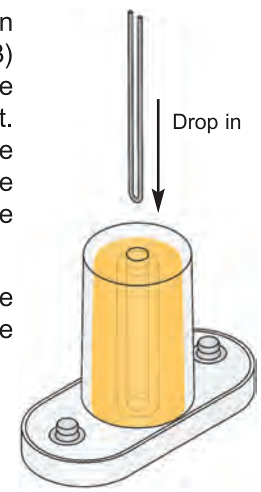
Paperclip Oscillator (II)

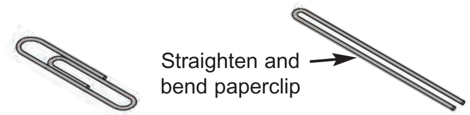
***OBJECTIVE:** To show how electricity can lift things using magnetism.*



Take a paperclip and straighten it out, bend it in half, and place it into the electromagnet (M3) center. Turn on the slide switch (S1), and set the adjustable resistor (RV) control lever to the right. The paperclip gets sucked into the center of the electromagnet and stays suspended there. Move the adjustable resistor lever to the left, and the paperclip falls.

Now for the fun part: Slowly slide the adjustable resistor lever until you find a spot where the paperclip is bouncing up and down.

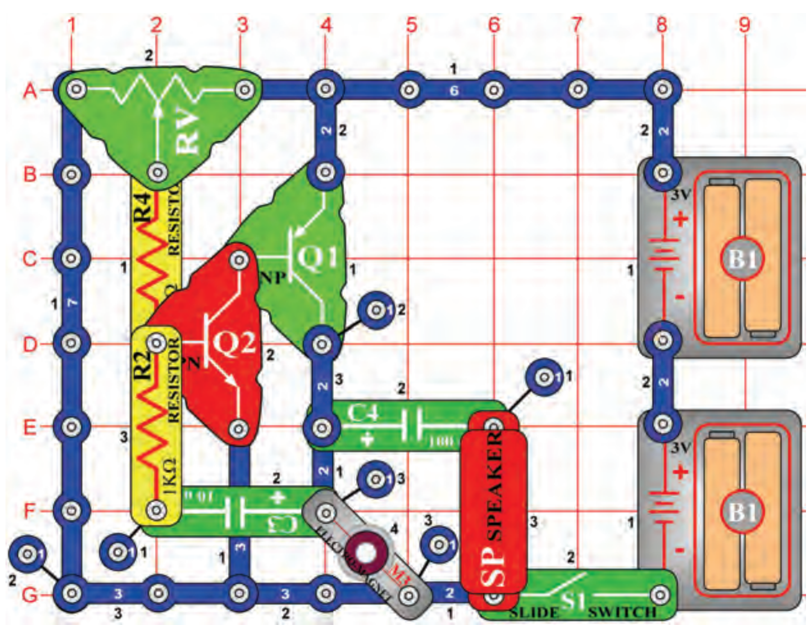




Project #671

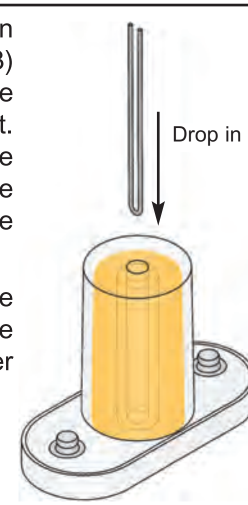
Paperclip Oscillator (III)

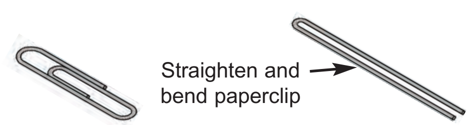
***OBJECTIVE:** To show how electricity can lift things using magnetism.*



Take a paperclip and straighten it out, bend it in half, and place it into the electromagnet (M3) center. Turn on the slide switch (S1), and set the adjustable resistor (RV) control lever to the right. The paperclip gets sucked into the center of the electromagnet and stays suspended there. Move the adjustable resistor lever to the left, and the paperclip falls.

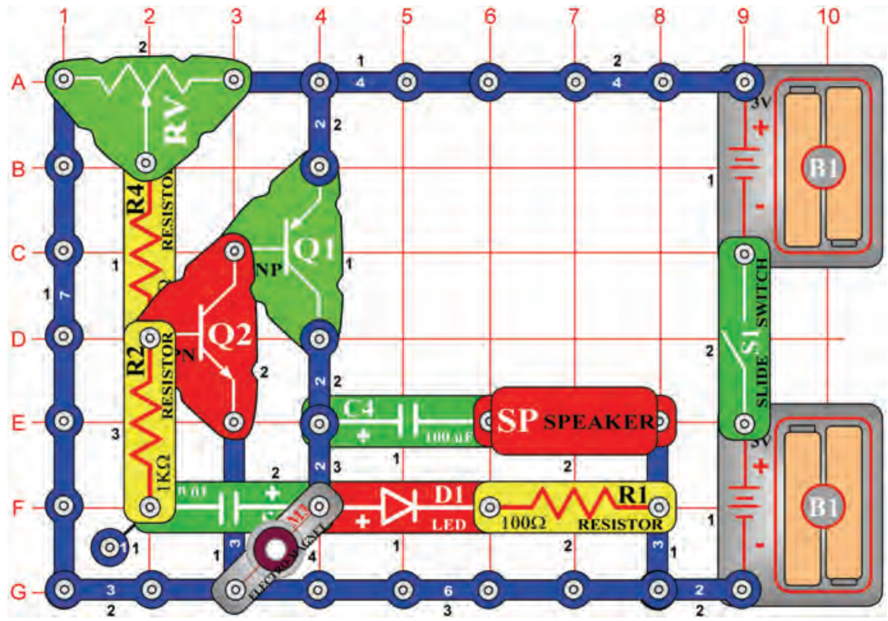
Now for the fun part: Slowly slide the adjustable resistor lever until you find a spot where the paperclip is bouncing up and down. The speaker (SP) makes a clicking sound.





To learn more about how circuits work, visit www.snapcircuits.net or page 85 to find out about our Student Guides.

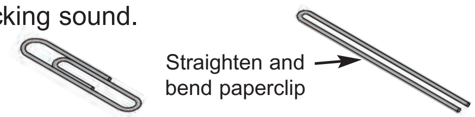
☐ Project #672 Paperclip Oscillator (IV)

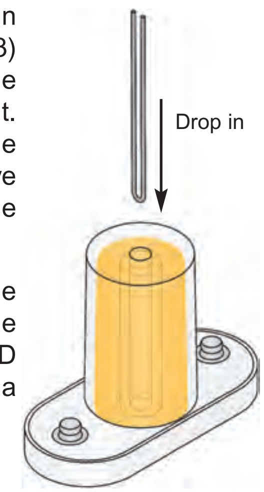


OBJECTIVE: To show how electricity can lift things using magnetism.

Take a paperclip and straighten it out, bend it in half, and place it into the electromagnet (M3) center. Turn on the slide switch (S1), and set the adjustable resistor (RV) control lever to the right. The paperclip gets sucked into the center of the electromagnet and stays suspended there. Move the adjustable resistor lever to the left, and the paperclip falls.

Now for the fun part: slowly slide the adjustable resistor lever until you find a spot where the paperclip is bouncing up and down. The LED (D1) flashes and the speaker (SP) makes a clicking sound.





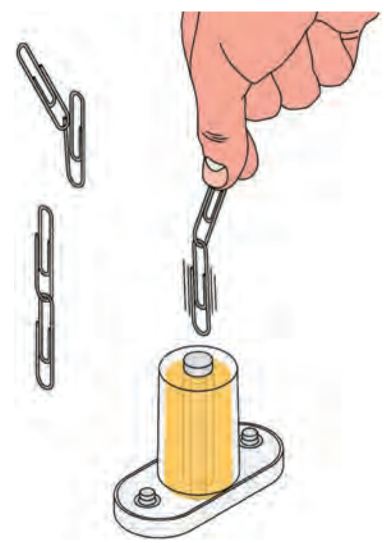
☐ Project #673 Paperclip Oscillator (V)

OBJECTIVE: To show how electricity can lift things using magnetism.

Use the circuit from project #672, but replace the 100μF capacitor (C4) with a 3-snap wire and replace the speaker (SP) with the 6V lamp (L2). The circuit works the same way, but the lamp flashes like a strobe light.

☐ Project #674 Oscillating Compass

OBJECTIVE: To learn how electricity and magnetism are related.

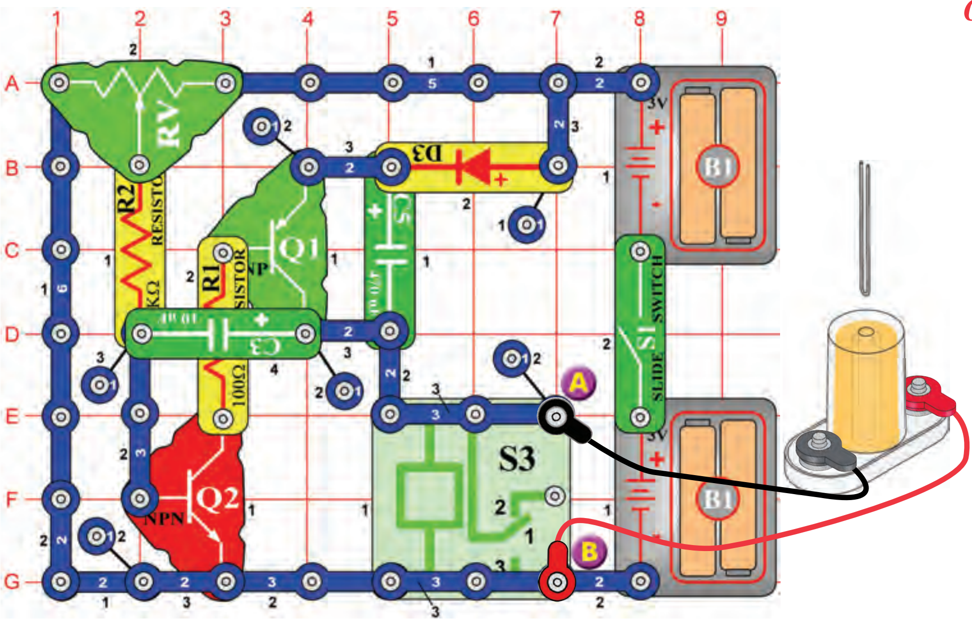


Use the circuit from project #672, but replace the 100μF capacitor (C4) with a 3-snap wire and replace the speaker (SP) with the 6V lamp (L2). Place the iron core rod in the electromagnet (M3) and don't use the bent paperclip. Slide two paperclips together, using their loops.

Turn on the slide switch (S1) and hold the paperclips just above the electromagnet, without them touching the iron core rod. Watch how the lower paperclip is drawn toward the iron core rod. Notice that the lower paperclip is vibrating, due to the changing magnetic field from this oscillator circuit. Compare this circuit to project #665 (Paperclip Compass).

Project #675 High Frequency Vibrator

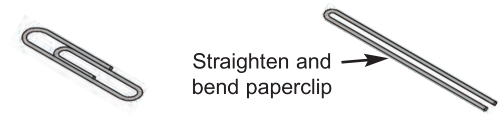
OBJECTIVE: To show how electricity can lift things using magnetism.



Take a paperclip and straighten it out, bend it in half, and place it into the electromagnet (M3) center. Connect the electromagnet to points A & B with the jumper wires and hold it about 1 inch above the table. Slide the adjustable resistor (RV) control lever around slowly, you will hear a clicking sound from the relay (S3).

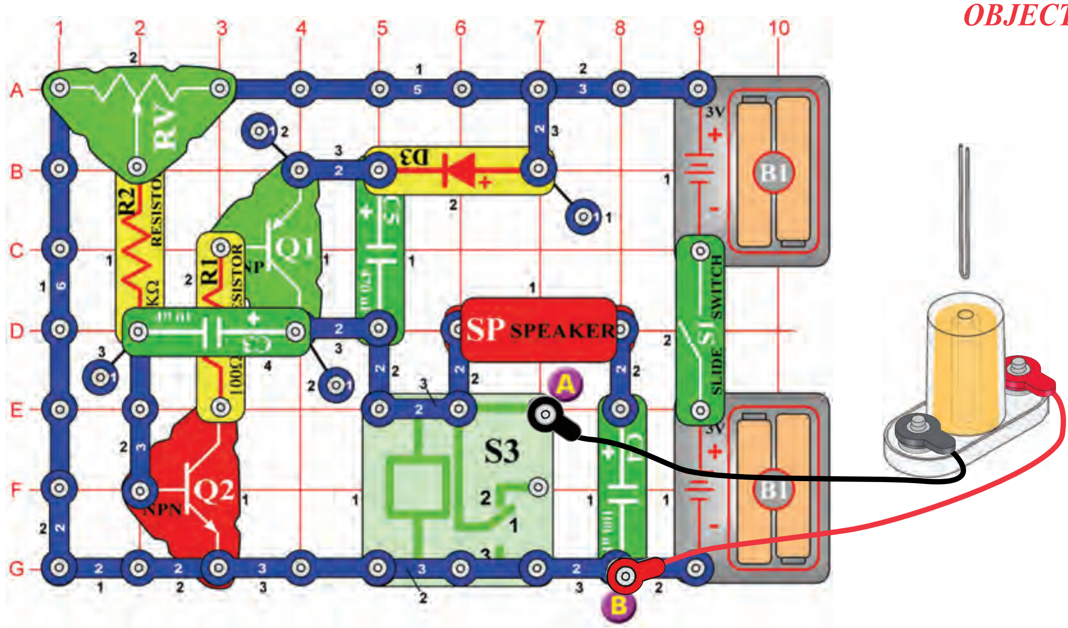
Adjust the electromagnet height and resistor control lever until the paperclip vibrates up and down on the table. It will vibrate at a fast rate but will not move very high. Usually this works best with the electromagnet about one inch above the table and the resistor control about mid-way to the right side, but your results may vary. See how high you can make the paperclip bounce.

Adjust the electromagnet height and resistor control lever to change the height and frequency of the vibration.



Project #676 High Frequency Vibrator (II)

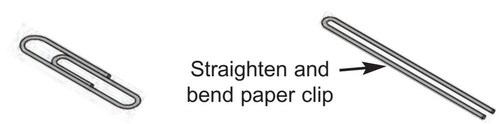
OBJECTIVE: To show how electricity can lift things using magnetism.



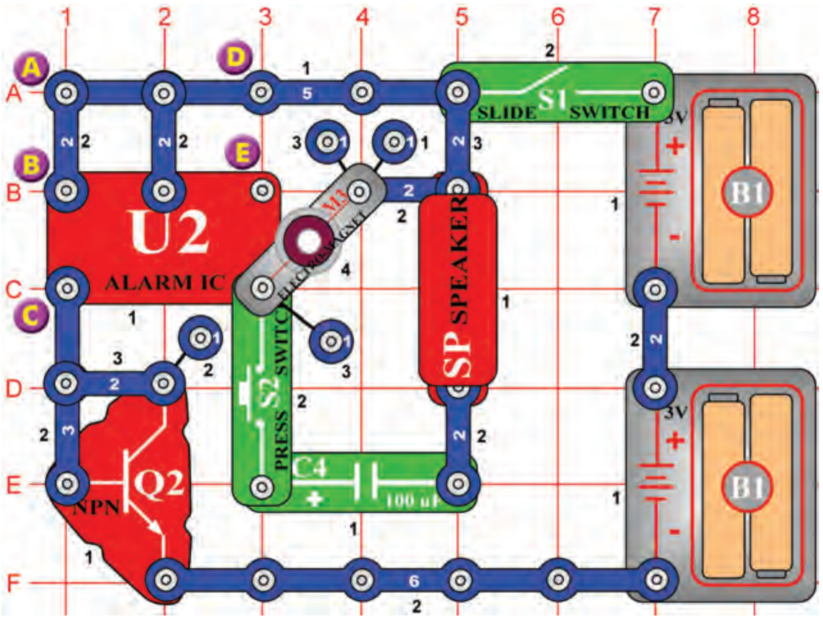
Take a paper clip and straighten it out, bend it in half, and place it into the electromagnet (M3) center. Connect the electromagnet to points A & B with the jumper wires and hold it about 1 inch above the table. Slide the adjustable resistor (RV) control lever around slowly, you will hear a clicking sound from the relay (S3) and speaker (SP).

Adjust the electromagnet height and resistor control lever until the paper clip vibrates up and down on the table. It will vibrate at a fast rate but will not move very high. Usually this works best with the electromagnet about one inch above the table and the resistor control about mid-way to the right side, but your results may vary. See how high you can make the paper clip bounce.

Adjust the electromagnet height and resistor control lever to change the height and frequency of the vibration.



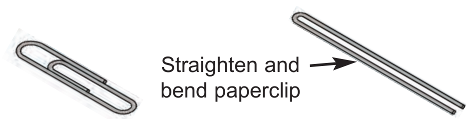
Project #677 Siren Paperclip Vibrator

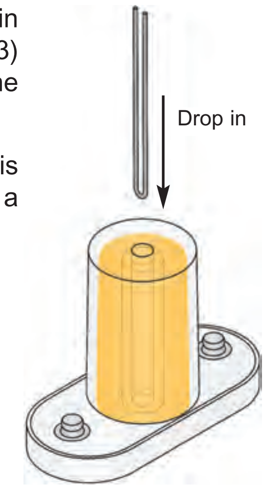


OBJECTIVE: To show how electricity can move things using magnetism.

Take a paperclip and straighten it out, bend it in half, and place it into the electromagnet (M3) center. Turn on the slide switch (S1), and the paperclip should vibrate.

Now press the press switch (S2), the paperclip is suspended in the air by the electromagnet and a siren alarm sounds.





Project #678 Alarm Paperclip Vibrator

OBJECTIVE: To show how electricity can move things using magnetism.

Use the circuit from project #677, remove the connection between points A & B and make a connection between points B & C (using a spacer on point B). The sound and vibration are different now. Compare the vibration height and frequency to project #677.

Project #679 Machine Gun Paperclip Vibrator

OBJECTIVE: To show how electricity can move things using magnetism.

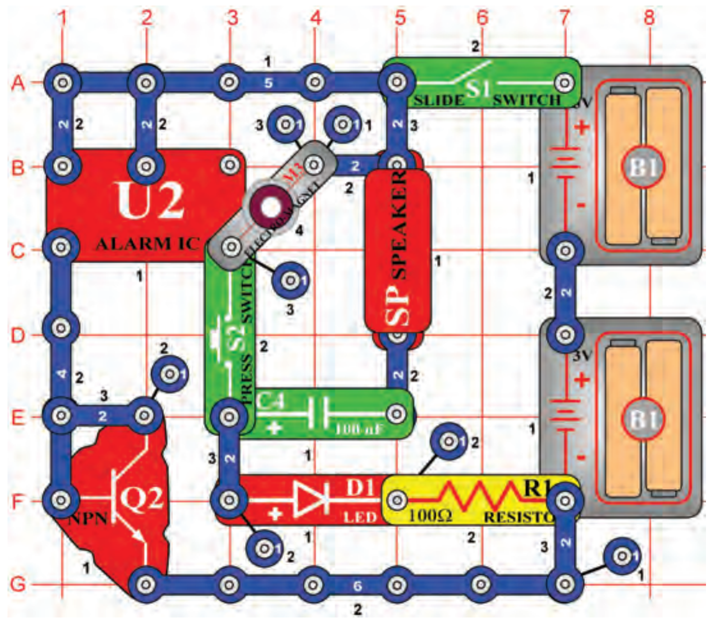
Now remove the connection between points B & C and make a connection between points D & E. The sound and vibration are different now. Compare the vibration height and frequency to projects #677 and #678.

☐

Project #680

Alarm Vibrator w/ LED

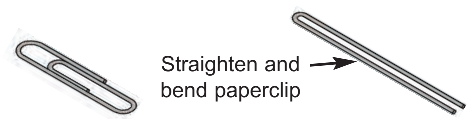
OBJECTIVE: To show how electricity can move things using magnetism.

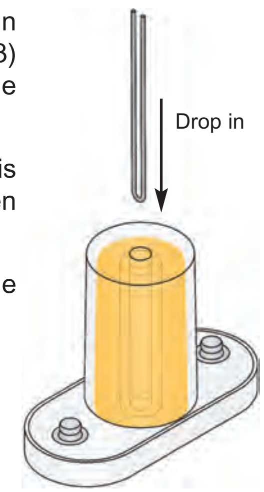


Take a paperclip and straighten it out, bend it in half, and place it into the electromagnet (M3) center. Turn on the slide switch (S1), and the paperclip should vibrate and LED (D1) flashes.

Now press the press switch (S2), the paperclip is sucked up by the electromagnet and a siren alarm sounds.

You can replace the speaker (SP) with the whistle chip (WC) to change the sound.





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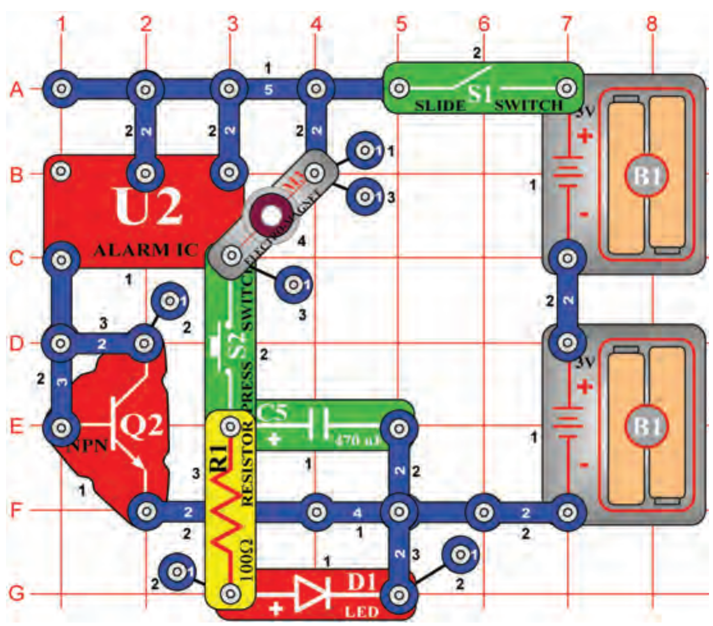
Project #681

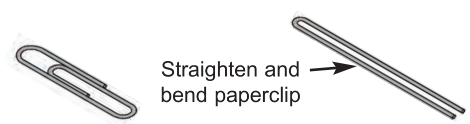
Alarm Vibrator w/ LED (II)

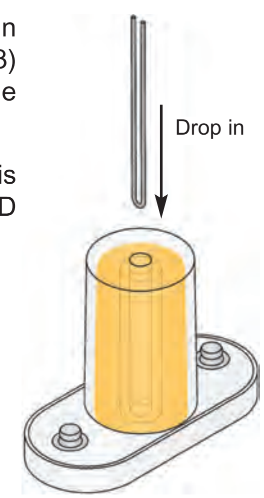
OBJECTIVE: To show how electricity can move things using magnetism.



Take a paperclip and straighten it out, bend it in half, and place it into the electromagnet (M3) center. Turn on the slide switch (S1), and the paperclip should vibrate.

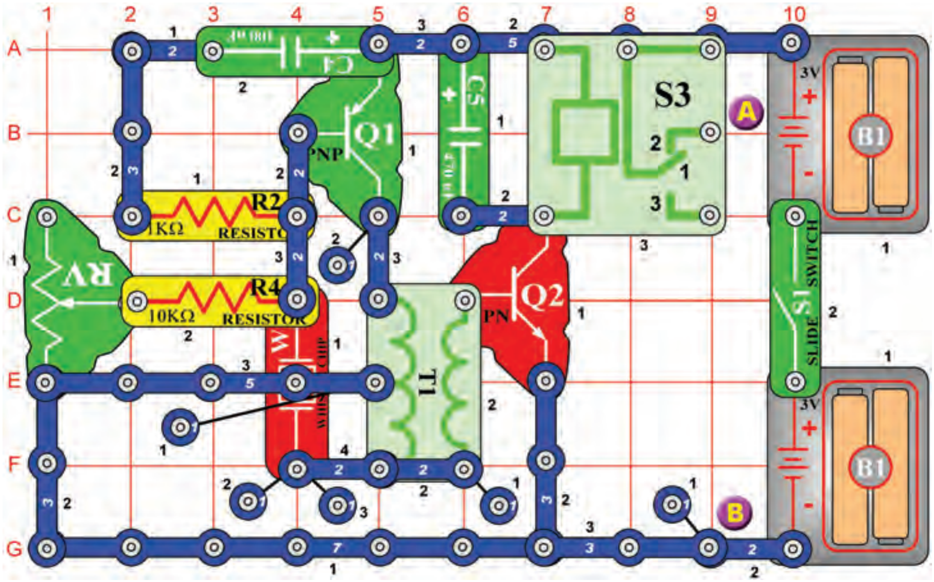
Now press the press switch (S2), the paperclip is sucked up by the electromagnet and the LED (D1) flashes.





Project #682 Relay-Whistle Vibrator

OBJECTIVE: To show how electricity can lift things using magnetism.

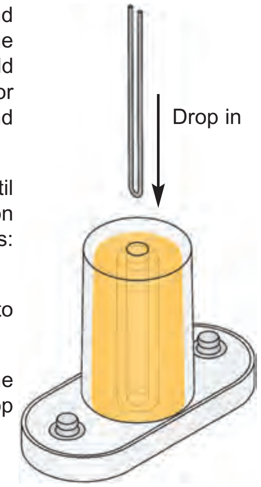


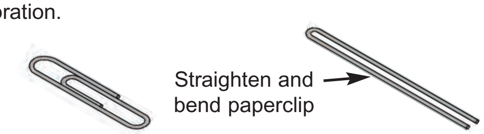
Take a paperclip and straighten it out, bend it in half, and place it into the electromagnet (M3) center. Connect the electromagnet to points A & B with the jumper wires and hold it about 1 inch above the table. Slide the adjustable resistor (RV) control lever around slowly, you will hear a clicking sound from the relay (S3) and buzzing from the whistle chip (WC).

Adjust the electromagnet height and resistor control lever until the paperclip vibrates up and down on the table. The vibration pattern may seem complex because it is due to two sources: the whistle chip and the relay.

Adjust the electromagnet height and resistor control lever to change the height and frequency of the vibration.

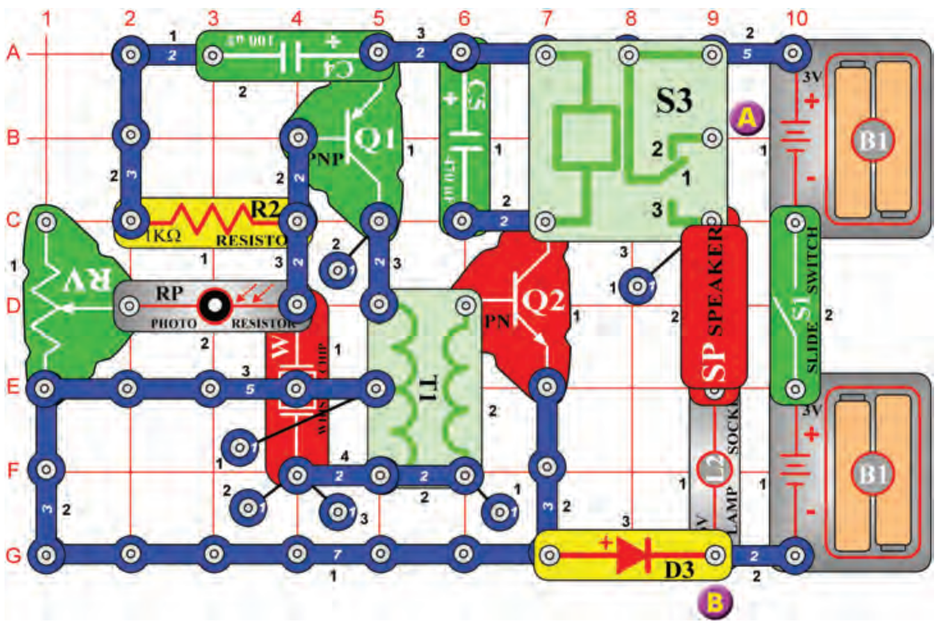
You can also replace the 10KΩ resistor (R4) with the photoresistor (RP). Waving your hand over it will start or stop the vibration.





Project #683 Relay-Whistle Photo Vibrator

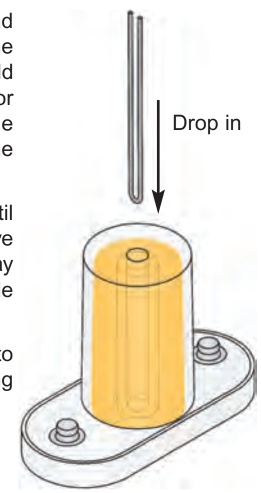
OBJECTIVE: To show how electricity can lift things using magnetism.

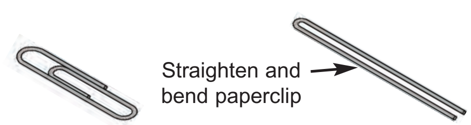


Take a paperclip and straighten it out, bend it in half, and place it into the electromagnet (M3) center. Connect the electromagnet to points A & B with the jumper wires and hold it about 1 inch above the table. Slide the adjustable resistor (RV) control lever around slowly without covering the photoresistor (RP), you will hear a clicking sound from the relay (S3) and buzzing from the whistle chip (WC).

Adjust the electromagnet height and resistor control lever until the paperclip vibrates up and down on the table. Then wave your hand over the photoresistor. The vibration pattern may seem complex because it is due to three sources: the whistle chip, the relay, and the photoresistor.

Adjust the electromagnet height and resistor control lever to change the height and frequency of the vibration. Covering the photoresistor stops the vibration.

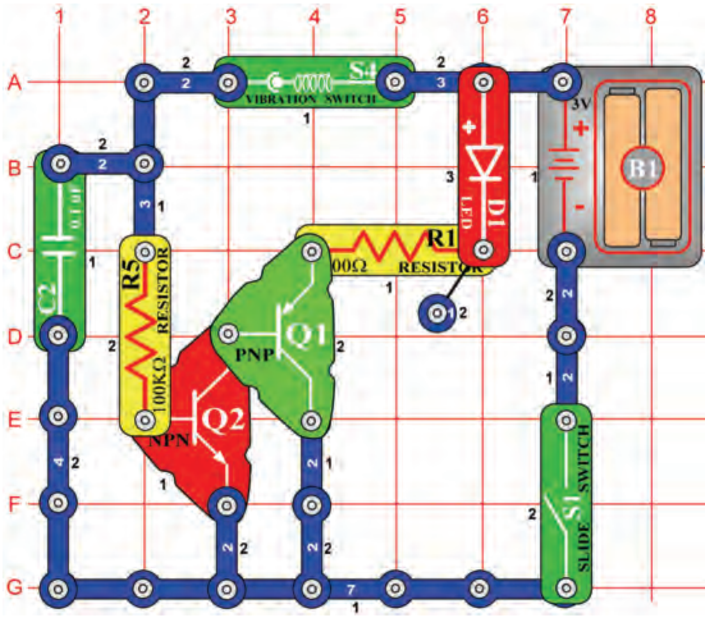




☐ # Project #684

Vibration LED

OBJECTIVE: Introduction to the vibration switch.



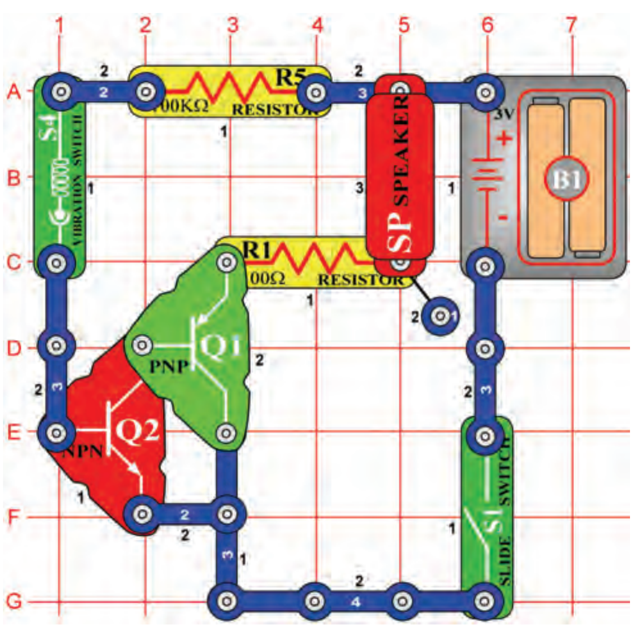
The vibration switch (S4) contains two separate contacts; a spring is connected to one of the contacts. A vibration causes the spring to move briefly shorting the two contacts. This simple circuit demonstrates how the vibration switch works. Build the circuit and the LED (D1) does not light. Tap the vibration switch or table and the LED lights for every tap.

The 100KΩ resistor (R5) limits the current to protect the vibration switch while the transistors allow the vibration switch to control a large current.

☐ # Project #685

Vibration Speaker

OBJECTIVE: To create sound with a tap of your finger.



Build the circuit and turn on the slide switch (S1). When you tap on the vibration switch (S4), the speaker (SP) sounds. Listen closely because the sound may not be very loud.

☐ # Project #686

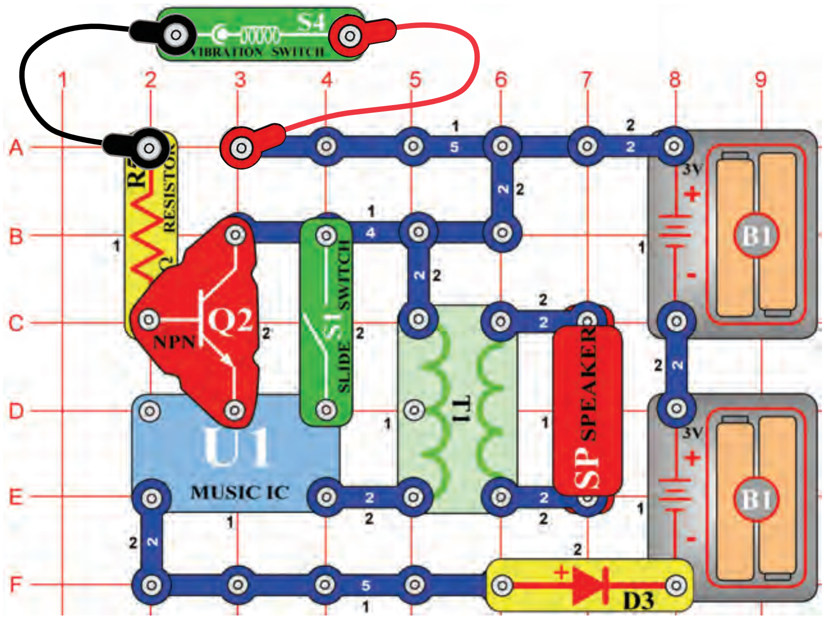
Measure the Vibration as You Tap the Switch

OBJECTIVE: To use the meter with the vibration switch.

Modify project #685 by replacing the speaker (SP) with the meter (M2). Place it with the "+" side towards R5 and use the LOW (or 10mA) setting. Tap the vibration switch (S4) and the meter deflects to the right. Tap harder on the switch; the switch closes longer and the meter deflects more to the right.

Project #687 Shaky Birthday Song

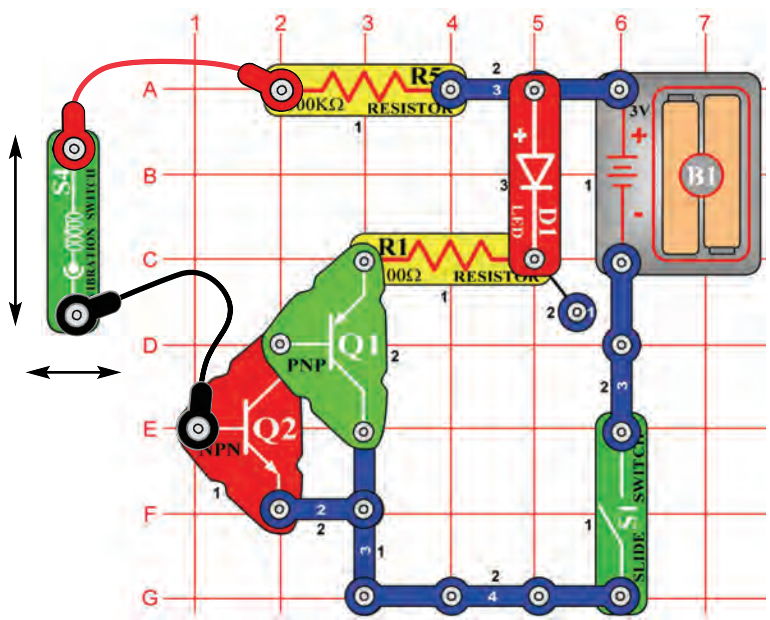
OBJECTIVE: To turn the music IC on and off using the vibration switch.



Connect the vibration switch (S4) to the circuit using the red and black jumpers. Hold the vibration switch steady in your hand and the music should not play. Now move your hand, the music should briefly play. If you continuously shake the switch, the music keeps playing. Turn the slide switch (S1) on and the music plays. Change the sound by shaking the vibration switch.

Project #688 Vibration Detector

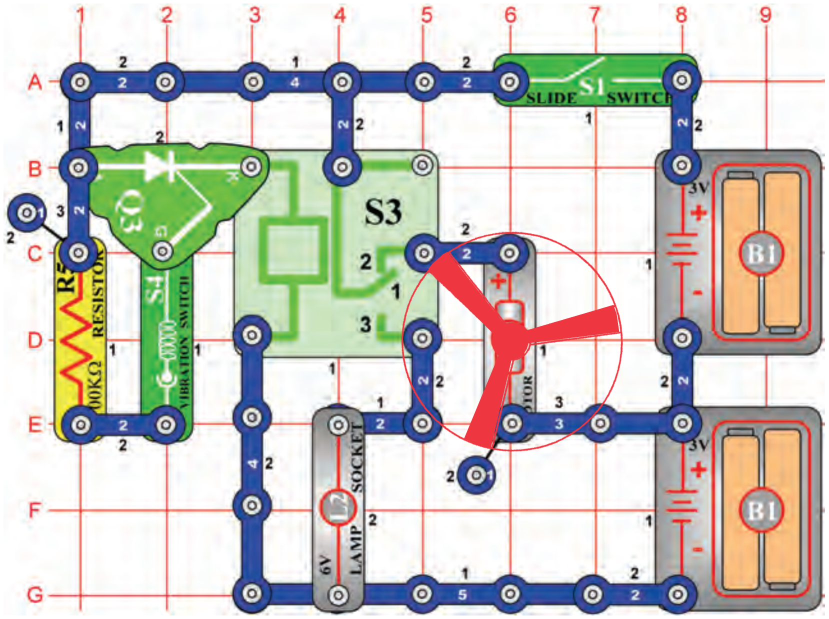
OBJECTIVE: To show the effects of horizontal and vertical direction.



Connect the vibration switch (S4) to the circuit using the black and red jumper wires. Place the switch horizontally on the table. Rapidly move the switch from left to right and notice that the LED (D1) does not light. There is not enough force to expand the internal spring to turn on the switch. Now move the switch up and down and see that the LED easily lights. It requires less force to move the spring back and forth.

You can replace the LED (D1) with the meter (M2), place it with the "+" side towards R5 and use the LOW (or 10mA) setting. The meter deflects more when you move the vibration switch up and down.

Project #689 — Out of Balance



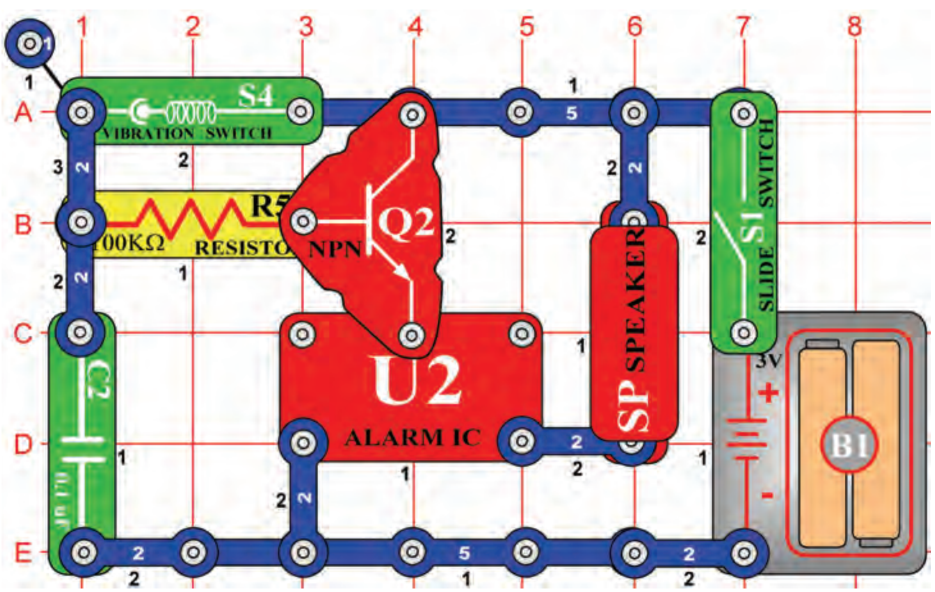
OBJECTIVE: To build an out of balance turn off circuit.

The vibration switch (S4) triggers the SCR (Q3) connecting the relay's (S3) coil to the battery (B1). The relay's contacts switch, turning the motor (M1) off, and lighting the lamp (L2). The lamp will stay lit until the slide switch (S1) is turned off.

Turn the slide switch on; the motor starts to spin. If the motor generates enough vibration, the switch will trigger the SCR, turning off the motor and lighting the lamp. If the motor keeps spinning, tap on the table to trigger the vibration switch.

WARNING: Moving parts. Do not touch the fan or motor during operation. Do not lean over the motor.

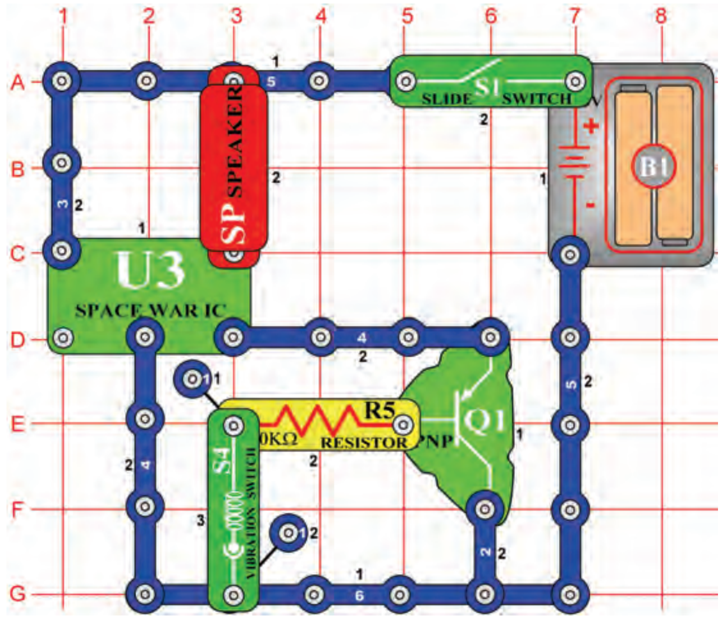
Project #690 — Vibration Alarm



OBJECTIVE: To sound an alarm when something is shaken.

Turn on the slide switch (S1) and shake the circuit or bang on the table; an alarm will sound. Try banging on the table in a regular pattern, and see if you can make the alarm sound continuously.

Project #691 — Vibration Space War

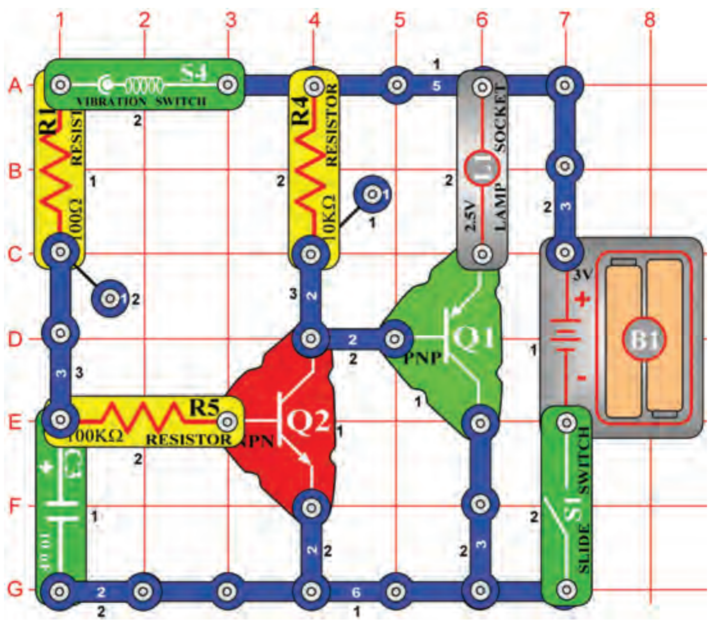


OBJECTIVE: To make sounds when something is shaken.

Turn on the slide switch (S1) and shake the circuit or bang on the table, you will hear different sounds. Try banging on the table in a regular pattern, and see if you can make the sounds continuous.

When the vibration switch (S4) is shaken, the circuit plays out one of eight sounds.

Project #692 — Vibration Light



OBJECTIVE: To build a lamp that stays on for a while.

Turn on the slide switch (S1) and shake the base grid or bang on the table. The lamp (L1) turns on when there is vibration, and stays on for a few seconds.

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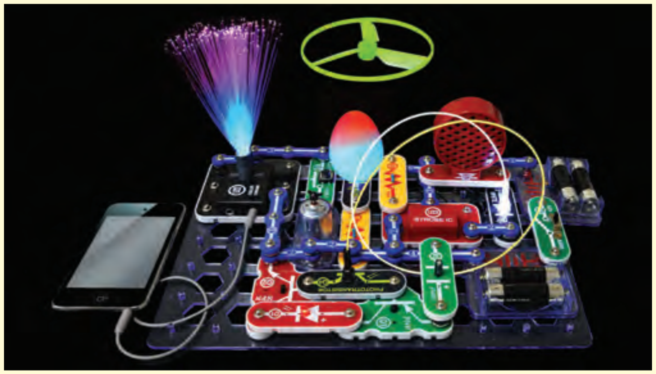

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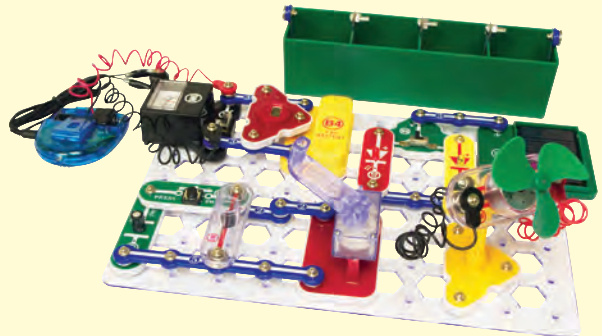
Learn about energy sources and how to "think green". Build over 125 projects and have loads of fun learning about environmentally-friendly energy and how the electricity in your home works. Includes full-color manual with over 100 pages and separate educational manual. This educational manual will explain all the forms of environmentally-friendly energy including: geothermal, hydrogen fuel cells, wind, solar, tidal, hydro, and others. Contains over 40 parts.



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- **Includes 30 parts**
- **Build over 20 projects**
- **Full-color assembly manual**
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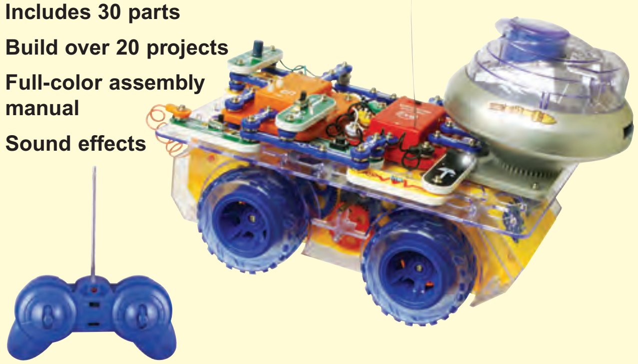

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Part # AC-SNAP

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Warning: This product contains uninflated balloons.

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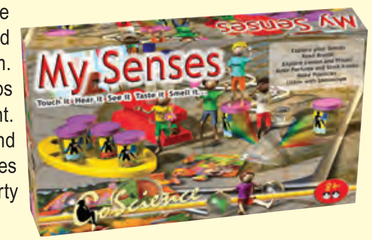
This kit is part of our Body Awareness Science Series, exploring the five senses: sight, hearing, smell, taste, and touch. Perform over 50 fascinating experiments. Use a genuine stethoscope, make a telescope with real lenses and create rainbows with a prism. Prepare perfume and stink bombs with chemistry lab equipment. Learn how to read and send messages in Braille. Also includes many activities suitable for party games.



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Model FUN-875

The purpose of this project is to expand your understanding of basic transmitters, receivers and electronic switching theories. Your Turbo King Car will be built from the ground up. You'll learn all about gears, motors, printed circuit boards, and integrated circuits from our detailed assembly and training manual. You will construct each section, explore the circuitry and troubleshoot it.

Requires 1 9V and 4 "AA" batteries.

Solar Deluxe Educational Kit

Model SK-40

By solar power, harness the power of the sun with this environment-friendly D.I.Y. kit!

You can do a series of do-it-yourself experiments to acquire the basic knowledge of solar energy.

You can learn how to make an electrical circuit, make a solar circuit, how to increase voltage and current, and how to use solar power to produce energy for a radio, calculator, battery charger, and more!

ELENCO®
150 Carpenter Avenue
Wheeling, IL 60090
(847) 541-3800
Website: www.elenco.com
e-mail: elenco@elenco.com

ELECTRONIC SNAP CIRCUITS™

With Computer Interface   Model CI-73

Experiments PC1 - PC73

SNAP CIRCUITS® ELENCO

Instruction Manual

Elenco® Electronics, Inc.

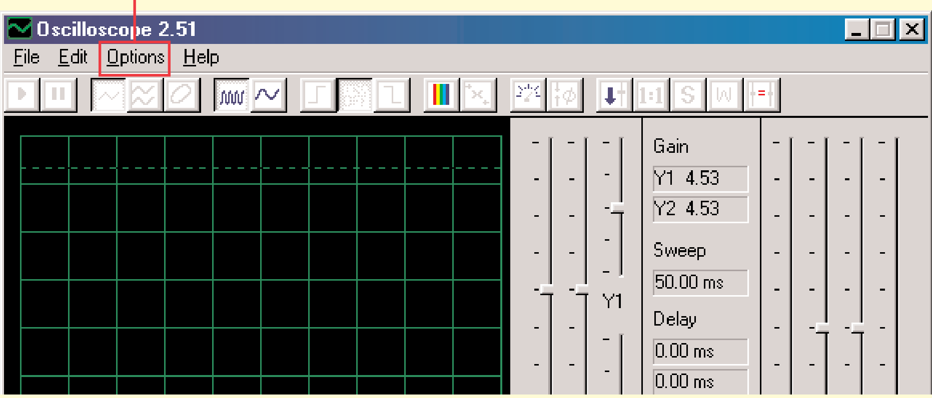
REV-B Revised 2005 753293

CI-73 - READ THIS FIRST

The CI-73 is a set of 73 Snap Circuits with special software that allows you to "see" the electrical signals in the circuits, just like electronics engineers do using oscilloscopes and spectrum analyzers.

Requirements for your computer:

1. Windows® 95 or later.
2. A working microphone input port.



INSTRUCTIONS:

1. Insert the CI-73 CD into your computer. The Snap Circuits menu comes up automatically, with an electronic copy of this manual. Select **Run Winscope Now**. <u>Connect the plug end of the probe to the microphone input on the back of your personal computer.</u>

   If the Snap Circuits menu does not appear automatically: Click <Start> - <Run> - <Browse>, then select CI-73 in your CD drive, then select AutorunPro and click <OK>.

   If Windows asks you how to open the file (or if you have Acrobat® Reader™ 3.0 or older), then you need to install Acrobat® Reader™: Click <Start> - <Run> - <Browse>, then select CI-73 in your CD drive, then select Acrobat® Installer and click <OK>. Follow the instructions to install, and then re-insert the CI-73 CD into your computer.

2. Change the default settings for Winscope by selecting <Options>. Then select <Timing> and change Sampling to 44100 and press <OK>. Then select <Options> again, then <Colors> - <Y1 Trace> and pick a bright color like pink. Then select <Options>, then <Save Setup> to save these settings as your default.

3. Follow the instructions through project PC3 before moving on to any other circuits, since the main features of the software are demonstrated.

If you have any questions contact:

Elenco® Electronics, Inc.
150 Carpenter Avenue
Wheeling, IL 60090
(847) 541-3800
Website: www.elenco.com • e-mail: elenco@elenco.com

WARNING:

SHOCK HAZARD - **<u>NEVER</u>** connect the probe to AC power or a wall electricity outlet for any reason since serious injury or damage may result.

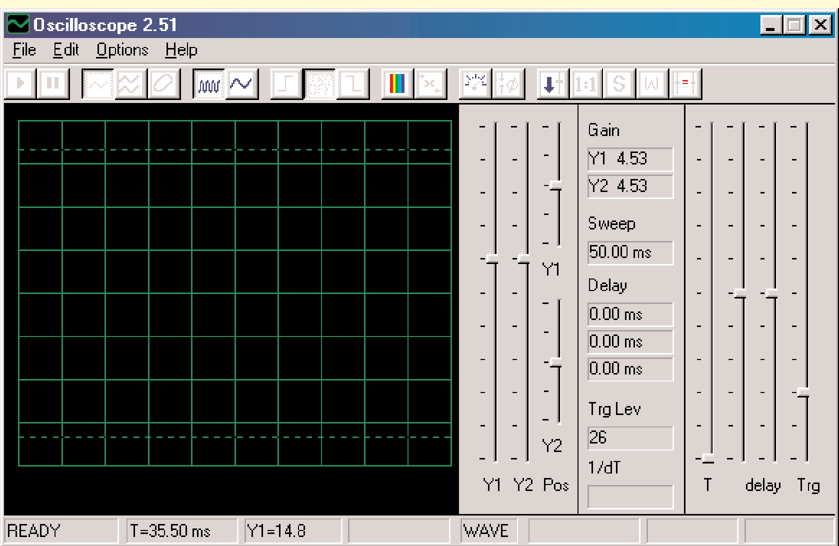
Looking at Electronic Signals using the WINSCOPE Software

Electronic engineers use specialized test equipment to “see” electronic signals and make performance measurements. They use an oscilloscope to look at the shape of the signal and use a spectrum analyzer to look at its frequency content. This equipment is specialized and usually very expensive.

The Winscope software simulates this equipment using your personal computer. The **PC-interface cable** can be connected across any 2 points in your circuit to look at the signal.

WARNING:
SHOCK HAZARD - **NEVER** connect the probe to AC power or a wall electricity outlet for any reason since serious injury or damage may result.

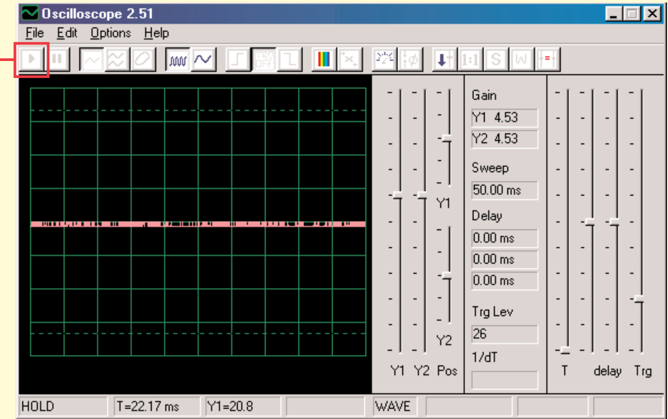
It is usually connected to the output of a circuit, as in the circuits shown for the CI-73. **Connect the plug end of the probe to the microphone input (pink plug) on the back of your personal computer.** Run the Winscope application (from the CI-73 menu). It will come up in Hold mode looking like this:



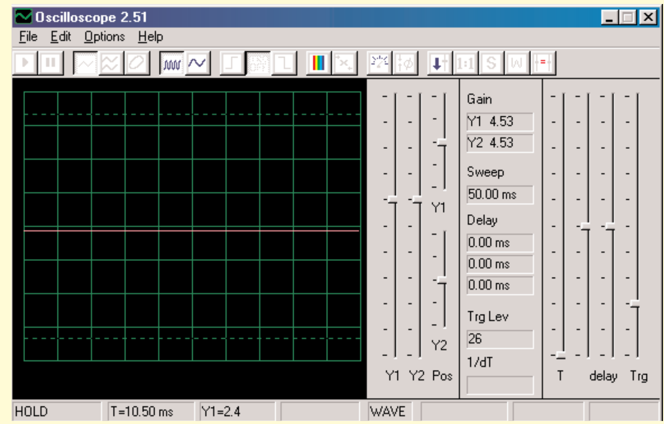
Click on the **On-Line button** to turn it on. You should now get one of the following 2 pictures, depending on whether your microphone input is properly turned on:

On-Line button

Example A



Example B

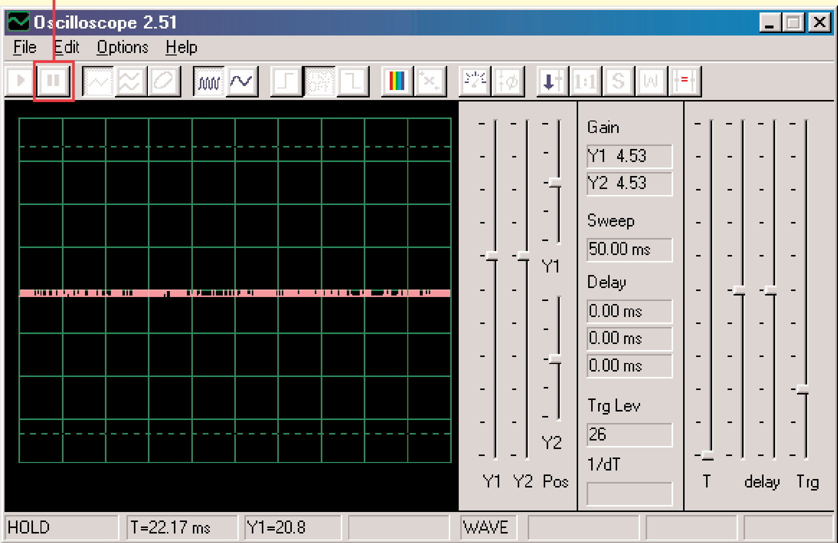


If you get the picture shown in Example B, then your microphone input is not properly turned on. Go to the “Turning On Your Microphone Input” section to turn it on. There may also be other sound card controls on your computer that you need to set. When your input is properly configured, you will get a picture like Example A above. Touch the red and black “alligator” clips on the PC-interface cable to each other and you should see the random pattern on the Winscope screen change as you do so. You are now ready to proceed with the first CI-73 experiment or you may investigate the Winscope software on your own.

Looking at Electronic Signals using the WINSCOPE Software (continued)

You may freeze a waveform on the screen by clicking on the **Hold mode button** (just to the right of the On-Line button).

Hold mode button



WARNING: Do not "save setup" in Winscope. Many of the buttons on Winscope control features that this manual will not be using. If you accidentally place the Winscope software into an unknown mode, you may always close and re-start Winscope. Doing so will reset all settings to those described in this booklet unless you have done a "save setup".

PROJECTS PC1-PC3 SHOW HOW TO USE THE MAIN FUNCTIONS OF WINSCOPE SO DO THEM FIRST!

NOTES:

1. **It is recommended that you disable or turn down the volume to the speakers on your computer. CI-73's use of the microphone input port will also channel the same signal to the speakers, and the result can be distracting.**
2. **It is recommended that you become familiar with the Snap Circuits parts and assembly methods before building any of the circuits in this manual.**

Turning On Your Microphone

(For Windows® 98 or XP, other Windows® versions may be slightly different.)

If you don't get any signal from the PC-interface cable then your microphone may be disabled on your computer. To turn it on, follow these instructions which begin by pressing the <Start> button on the lower-left corner:

1. Select <Start> - <Programs> - <Accessories> - <Entertainment> (or <Multimedia>) - <Volume Control>.
2. Select <Options>.
3. Select <Properties>.
4. Select <Recording> in the "Adjust Volume For" box.
5. In the "Show the Following Controls" box, check <Microphone>.
6. Select <OK>.
7. In the "Microphone - Volume" box, check <Select> and set volume to about 40% of max.

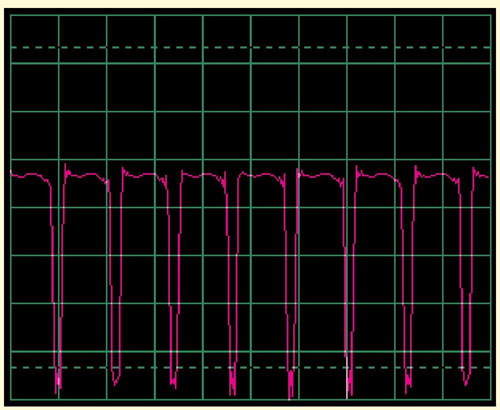
Your microphone should now be turned on.

Looking at Electronic Signals using the WINSCOPE Software (continued)

IMPORTANT NOTE: The designs for the microphone input port vary throughout the computer industry. Hence you may get waveforms different from those shown in your manual even though the circuit is actually performing the same way. Here are some types of differences:

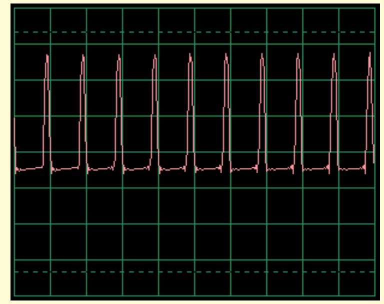
A. The gain of your microphone input may be significantly different from that indicated on pages 8-10 (and similarly for the other circuits). Page 4 describes how to turn on the microphone input and adjust its volume to about 40% of max, you may want to adjust this volume higher or lower so that your results better match those shown. Note that having the volume set too high may "clip off" the top or bottom portion of a waveform.

B. The oscilloscope waveforms shown on your display may appear upside down ("inverted") from those shown throughout this document. For example the waveform shown on the top of page 10 would look like this:

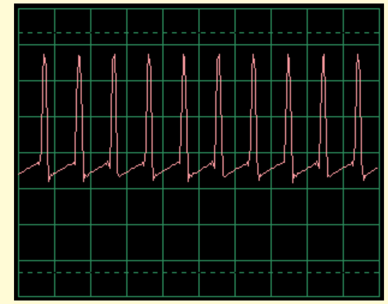


If this is the case then swap the connections of the red and black clips of the Winscope probe in all circuits.

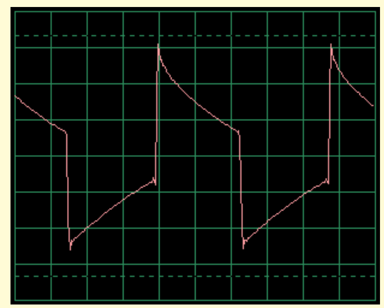
C. The shape of waveforms may appear distorted for some circuits, due to protection circuitry that acts as a filter. For example:



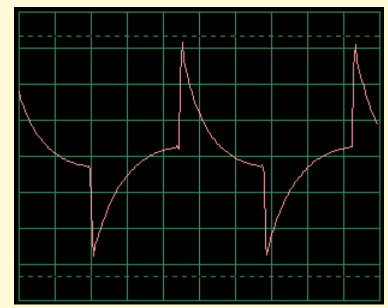
This waveform . . .



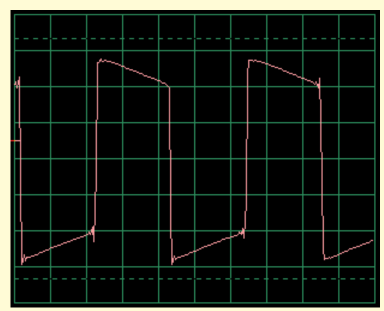
might look like this.



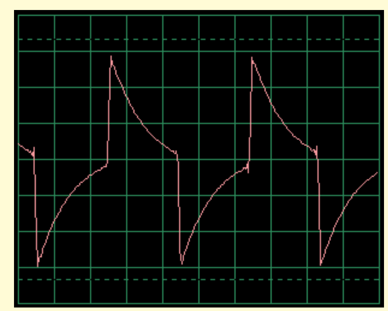
And this waveform . . .



might look like this.



And this waveform . . .



might look like this.

Contact Elenco® Electronics if you have any questions about this.

Limitations of WINSCOPE and Its Interface

By using the microphone audio input and the flexible processing power of the personal computer, we have created an inexpensive and easy-to-use way of looking at electronic signals. However, no electronic oscilloscope or spectrum analyzer ever made works on all electronic signals, and similarly Winscope has limitations. The projects in this booklet were written to minimize those limitations.

Winscope can only measure changing signals (AC voltages, >20 Hz frequency) and cannot measure fixed voltages (DC voltages, such as a battery), due to the design of the microphone input. Fixed voltages are not very exciting to look at anyway. Slow-changing or transient signals (such as when you first turn on power to a circuit) will be displayed in a distorted form.

Winscope works best on signals up to about 5kHz, since its sampling rate is limited to 44kHz. If you attempt to measure higher frequency signals, then you will get wrong results due to undersampling. This is a narrow range but it covers human voice and most (but not all) music. AM and FM radio frequencies cannot be measured. Every measurement you make will have some amount of random “chatter” superimposed on the signal of interest. This chatter is due to the limited sampling rate and from the PC-interface cable picking up energy from other electronic instruments in the vicinity (including room lights and your computer), hence it cannot be avoided.

Using WINSCOPE’s Full Capabilities

Winscope has 2 input channels that can be displayed at the same time. This is commonly done by electronic engineers using an oscilloscope, to show the relationship of one (or more) signals to another. However, use of this requires a second microphone input, which most computers do not have. If the sound card in your computer has this then you may use all of Winscope features for 2 channels, which include X-Y and correlate modes. Use of these Winscope capabilities is beyond the introductory level of this product, use the Help menu in Winscope for information about using these features.

WARNING:
SHOCK HAZARD - **NEVER** connect the probe to AC power or a wall electricity outlet for any reason since serious injury or damage may result.

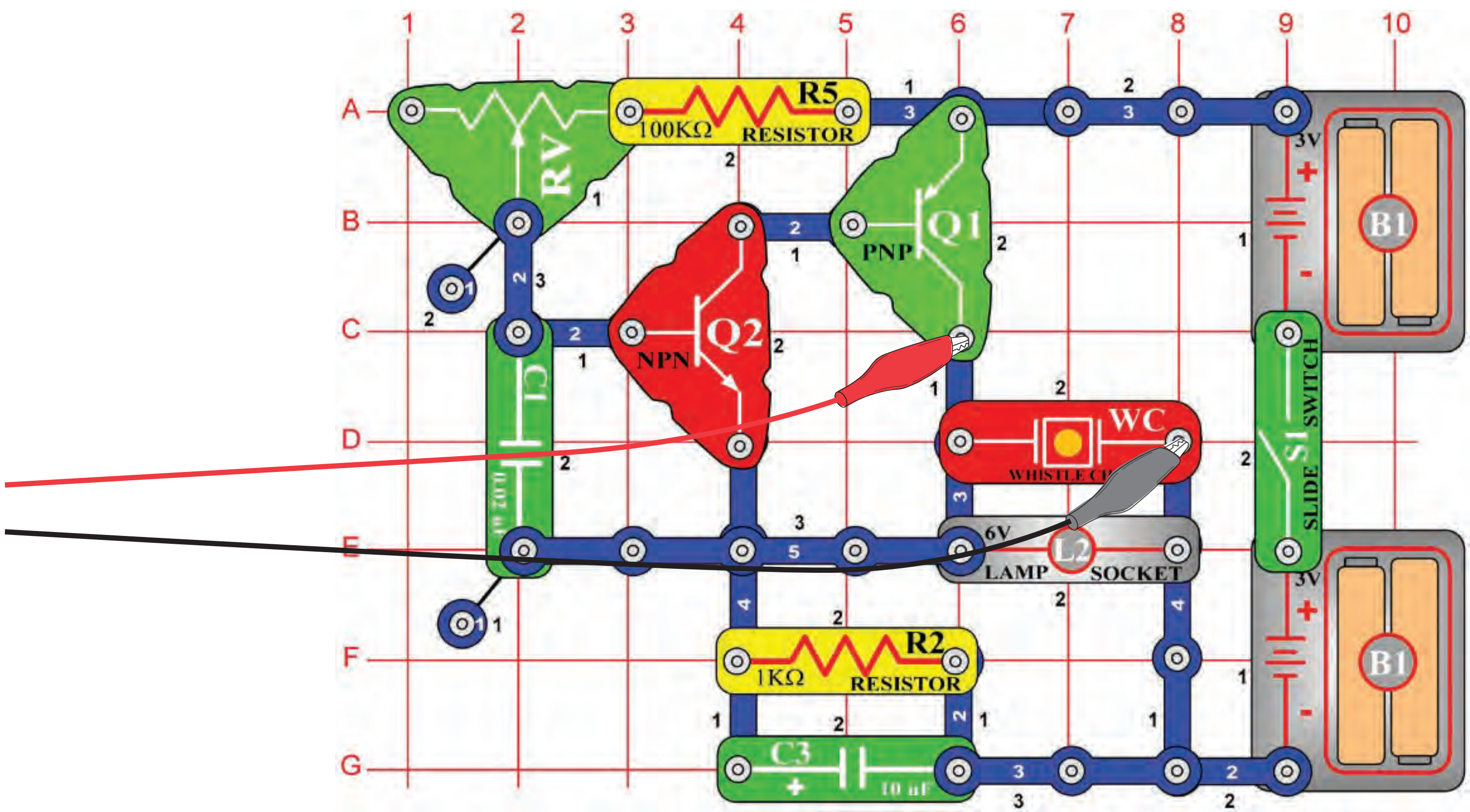
Exporting Graphs from WINSCOPE

To make a copy of the Winscope display screen, hold down the Alt button and press the PrtScn button on your computer when Winscope is the active window. You can then paste it into word processing programs such as Microsoft Word.

Project Listings

Project #PC1 Pitch PC

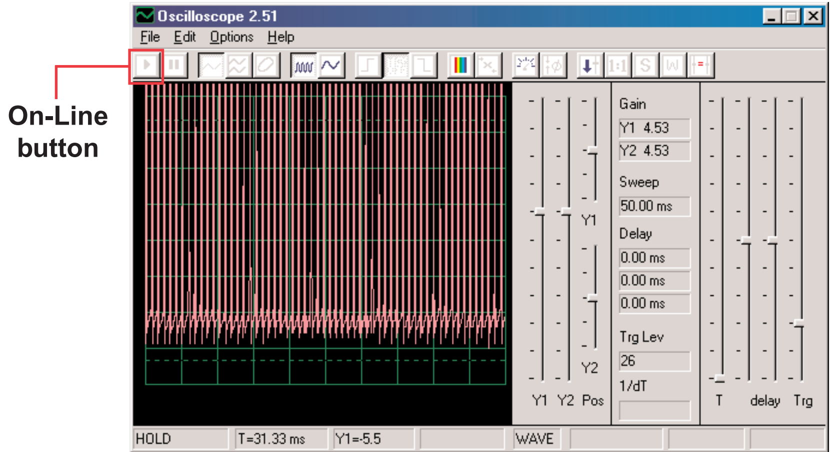
OBJECTIVE: To look at the output signal from a transistor oscillator while changing the pitch of the sound.



You will now be introduced to the Winscope features, and thereby become familiar with oscilloscopes and spectrum analyzers, and see some of the most important concepts in electronics. It is recommended that you already be familiar with the Snap Circuits parts and assembly methods from the other manuals.

Build the circuit shown and connect the PC-interface cable to the microphone input on your computer. Turn on the slide switch (S1) and vary the adjustable resistor (RV). The frequency or pitch of the sound is changed. Run the Winscope software and be sure your microphone input is configured properly, as described earlier.

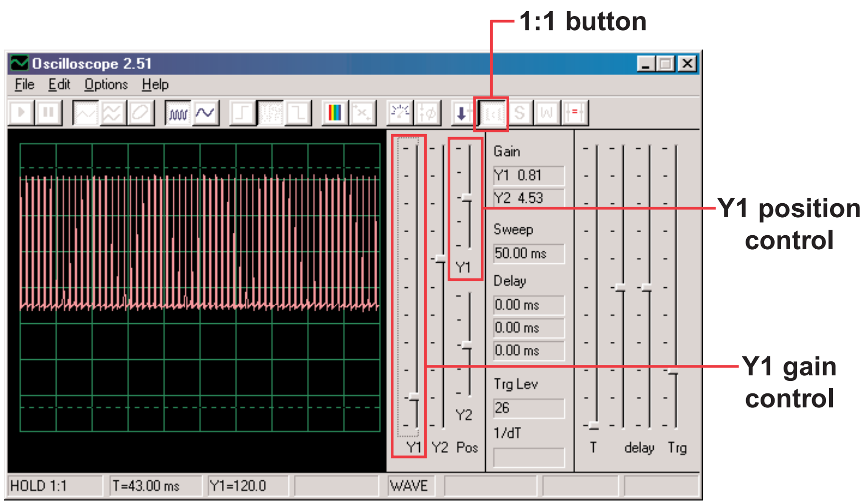
Click on the **On-Line button** if Winscope is currently in Hold mode and you should get a picture similar to this one:



The waveform peak is off the top of the screen because the scope gain (amplification) is set too high. You may adjust this gain by moving the **Y1 gain control** around (try it).

Similarly, you may adjust the position of the waveform on the screen by moving the **Y1 position control** around (try it).

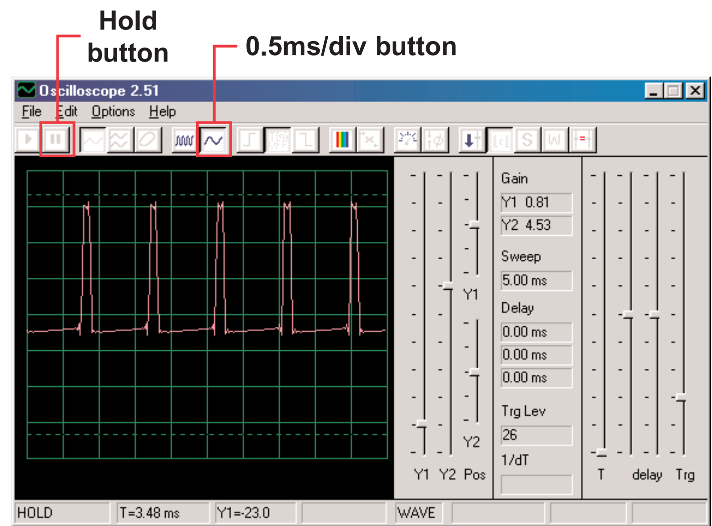
Now click on the **1:1 button** to set the gain to x1 and disable the Y1 controls. You should now have a picture similar to this one:



Note that your picture may not exactly match this picture due to variances in the microphone input gain between computers, which is beyond software control. You may want to adjust the volume control of your microphone input to compensate, see note A on page 4 for more details. You may also disable 1:1 mode by clicking on its button again and then adjust the gain using the Y1 control.

The gain and position control features just described enable electronic engineers and technicians to "see" the amplitude (voltage level) of a signal. By adjusting the settings on an oscilloscope, they can look at both very large and very small voltage waveforms.

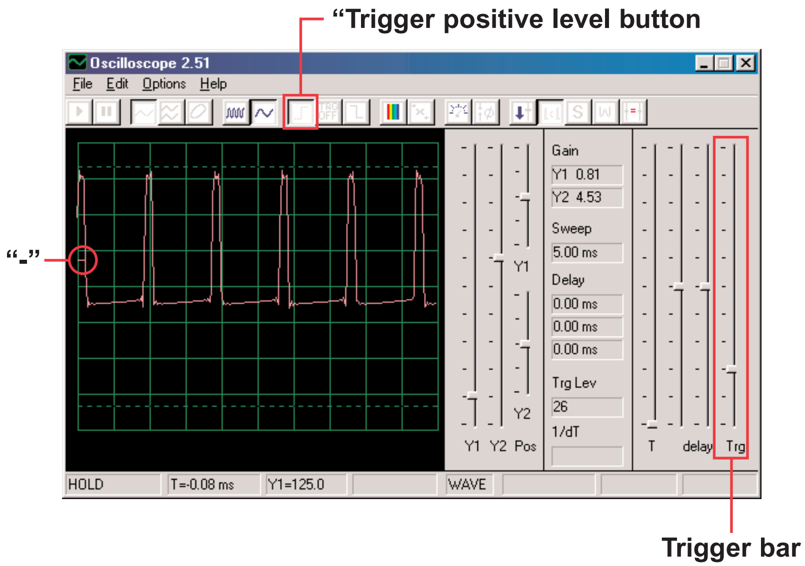
Move the adjustable resistor control (snap part RV) and watch how it changes the waveform on the computer screen. Now click on the **0.5ms/div button** to change the time scale on the display. (The button to the left of it is for 5ms/div, the default.) Move the adjustable resistor control around again. You may click on the **Hold button** to freeze the waveform on the screen, then click on On-Line to re-start.



With the time scale at 0.5ms/div and the adjustable resistor set for middle position, you should now have a picture similar to this one.

Your picture may appear different due to variations in the microphone input designs between computers. Although this is beyond software control, in some cases you may be able to compensate externally. See notes B and C on page 4 for details.

Notice that the waveform seems to be randomly dancing across the screen, making it hard to study. We can fix this. Click on the **"trigger positive level" button** and make sure the **trigger bar** is in the position shown here. Notice that a small **"-"** appears on the left of the display as you do so.

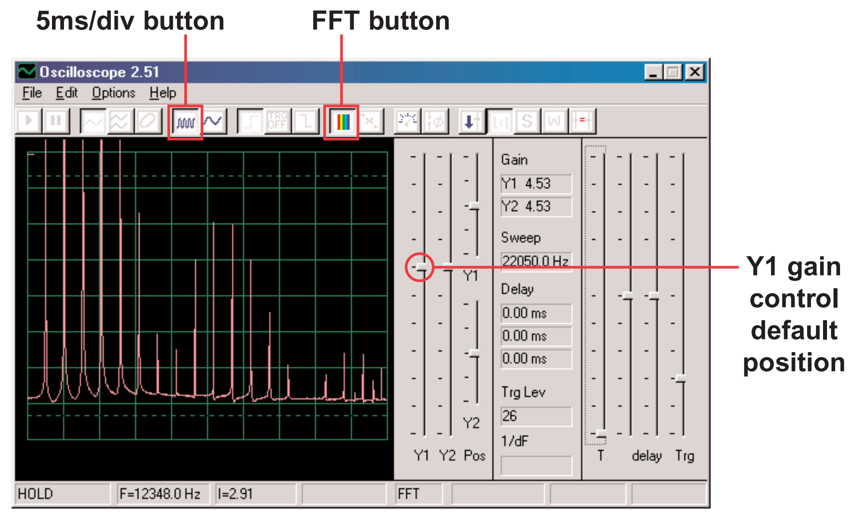


The small slash "-" represents the trigger voltage, when the signal reaches this voltage level it activates the display. This makes it easy to observe a stream of pulses like you have now, and also to record a single (non-repeating) pulse.

Move the adjustable resistor control (snap part RV) and watch how it changes the waveform on the computer screen. Now you can see how changing the adjustable resistor changes the time between the pulses, which changes the tone of the sound you hear.

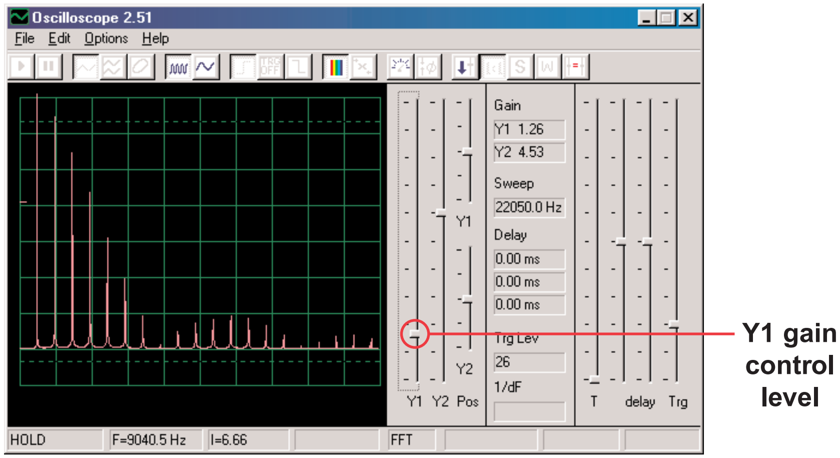
The waveform you see here is the voltage across the speaker, the peaks of the pulses occur when the transistors turn on and provide current to the speaker. Changing the amplitude of the peaks changes the loudness of the sound, changing their separation changes the tone or "pitch" of the sound. The time scale and trigger control features just described enable electronic engineers and technicians to see the relationship between parts of a waveform on their oscilloscope.

Now its time to look at your electronic signal in a different way. The oscilloscope features you have been using show you voltage (amplitude) vs. ***time***, now you will see voltage vs. ***frequency***. Engineers use expensive instruments called spectrum analyzers to do this, but Winscope uses a mathematical transformation called an FFT to do this. Set the Y1 gain control back to its **default position** for now. Click on the **5ms/div button** to display a wider range, then click on the **FFT button**. Your display should be similar to this:



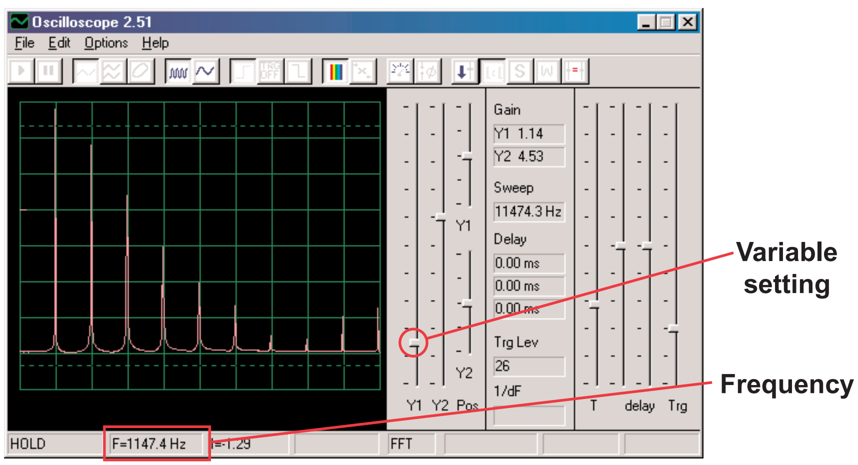
You are seeing the frequency spectrum of your signal, up to 22kHz. Notice that most of the energy is at the low frequencies (below 7kHz), and there is very little as you go higher.

The 1:1 gain mode does not apply to the FFT screen, so move the **Y1 gain control** down to here so you can see the peak energy at the low frequencies.



Move the adjustable resistor control (snap part RV) and watch how it changes the frequencies on the display.

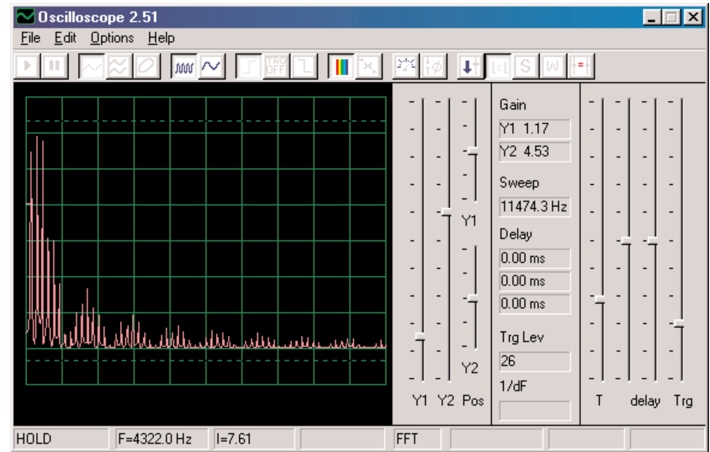
Set the adjustable resistor control (snap part RV) to mid-range. In addition to the 5ms/div and 0.5ms/div settings for the horizontal scale, there is also a **variable setting**. See if you can set it so that all the signal peaks line up with the grid lines, as shown.



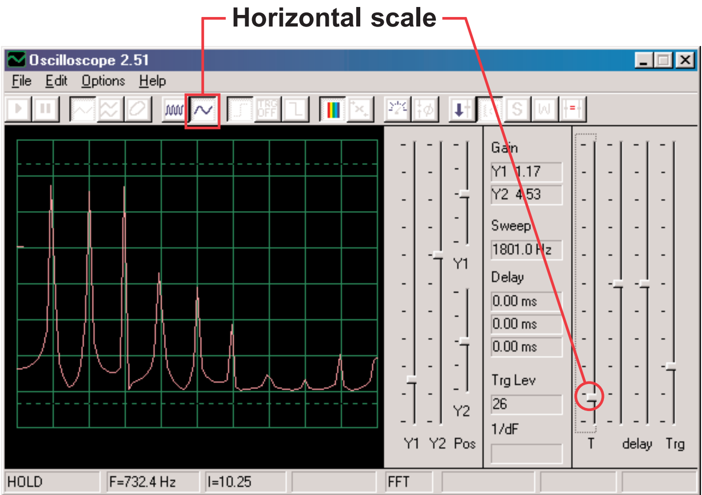
As you can see, all the peaks are equally spaced in frequency. Move your computer mouse directly over the first peak, the software displays the **frequency** you are pointing at. Move the mouse to the other peaks and you see they are multiples of the first frequency.

Now you can see that the tone you hear is actually a range of related frequencies combined together. The first peak is considered to be the main signal (and it is usually but not always the highest), the energy at all the other peaks determine the waveform of the signal you see on an oscilloscope.

Now modify your circuit by placing the 0.1μF capacitor (C2) on top of the 0.02μF capacitor (C1). By increasing circuit capacitance, you lower the oscillation frequency and your display should now look something like this:

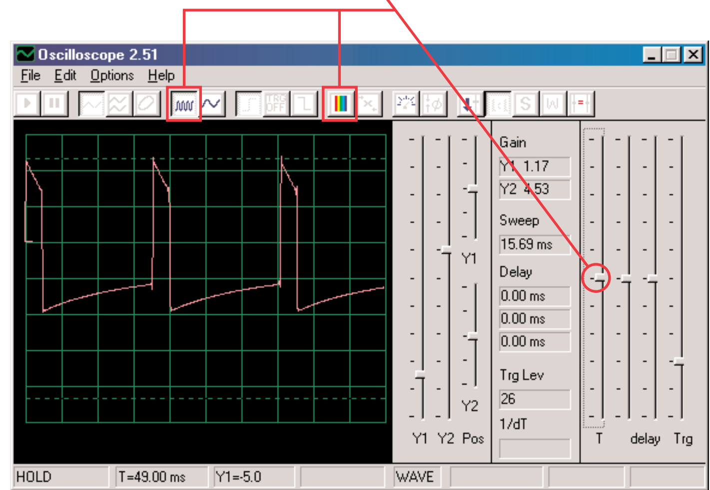


Now adjust the **horizontal scale** so the peaks line up with the gridlines as they did before.



Notice that all the peaks went down in frequency by a corresponding amount and many changed in amplitude, that is why your ears hear a different sound. Notice also that in this case the left-most frequency peak no longer is the highest in voltage (your results may vary).

Now you can click on the FFT box to return to oscilloscope mode and look at the waveform with the 0.1μF capacitor in the circuit. You can observe it with the same settings as before for comparison, but these settings usually work best:

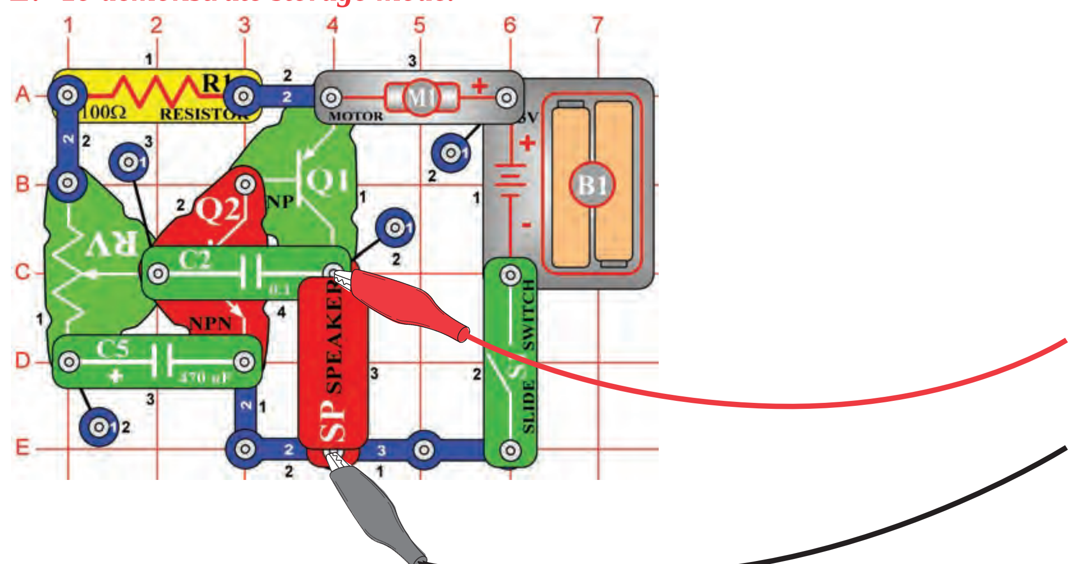


☐ Project #PC2 Screaming Fan PC

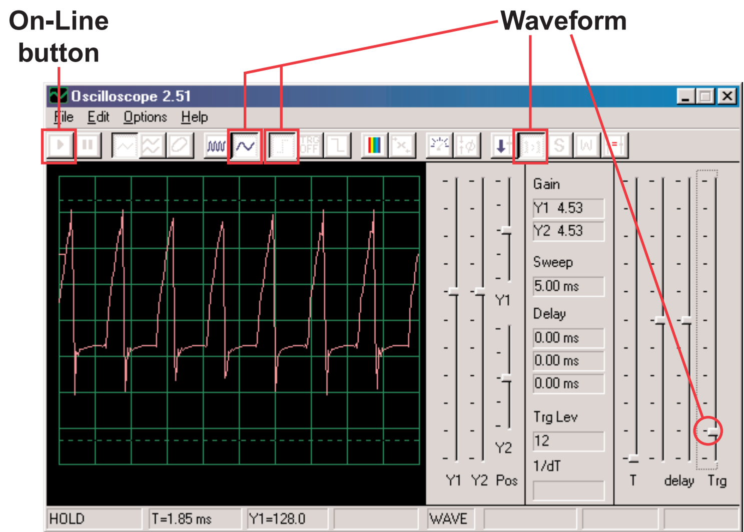
OBJECTIVE: To demonstrate storage mode.

WARNING: Moving parts. Do not touch the fan or motor during operation.

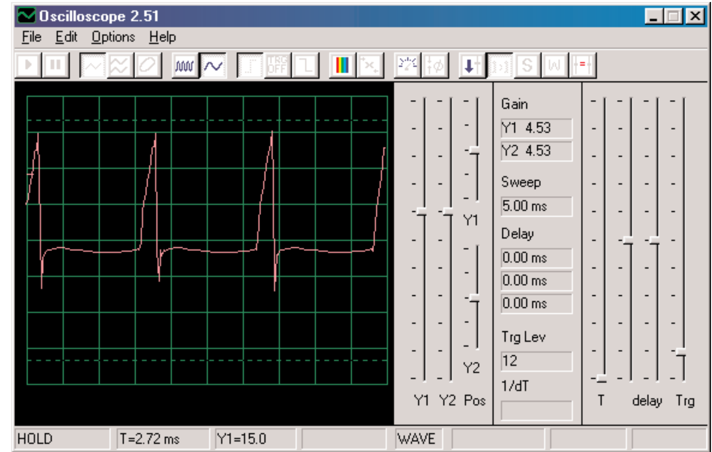
WARNING: Do not lean over the motor.



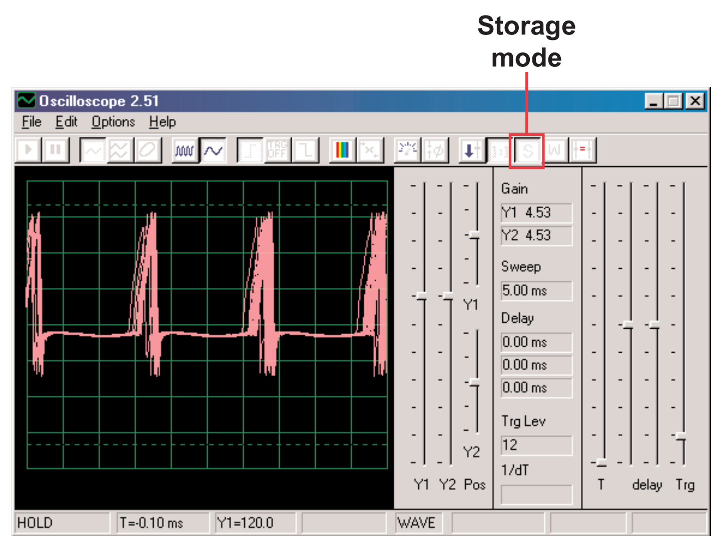
Build the circuit shown. If continuing from the previous experiment then close the Winscope program and run it again, to reset the settings. Click on the **On-Line button** to activate, and turn on the switch (snap part S1). Set Winscope to the settings shown below, and move the lever on the adjustable resistor (snap part RV) around to change **the waveform** and the sound. A sample waveform is shown here, but the pattern and shape of the pulses depends on the adjustable resistor setting.



Winscope has a mode that can display multiple scans at the same time, called **Storage mode**. Set the adjustable resistor lever to a low-middle position, place Winscope in this mode, and watch the results.



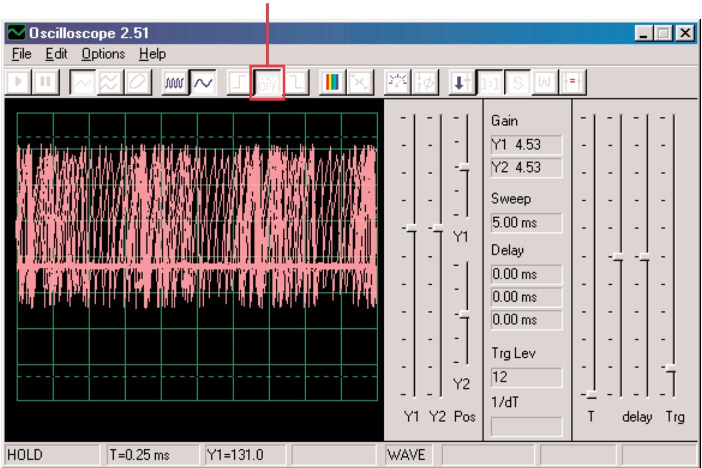
Without Storage Mode



With Storage Mode

What you see here is the effect of timing variations on the trigger used for synchronization. Turn off the **trigger** and you will see how much variation there is without using the trigger:

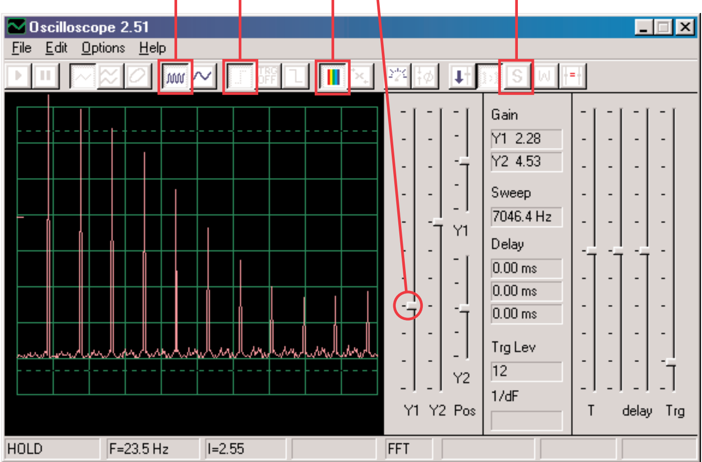
Trigger



You can use Storage mode on any of the other circuit waveforms if desired.

Now turn off storage mode and turn on FFT mode to look at the frequency spectrum, try the **settings** shown here.

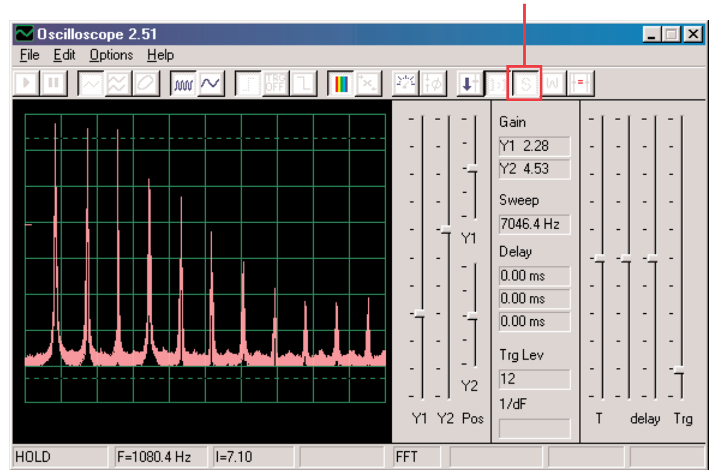
Settings



Moving the adjustable resistor lever will change the spectrum shown.

You can also use **storage mode** when in FFT mode, so turn it on now.

Storage mode

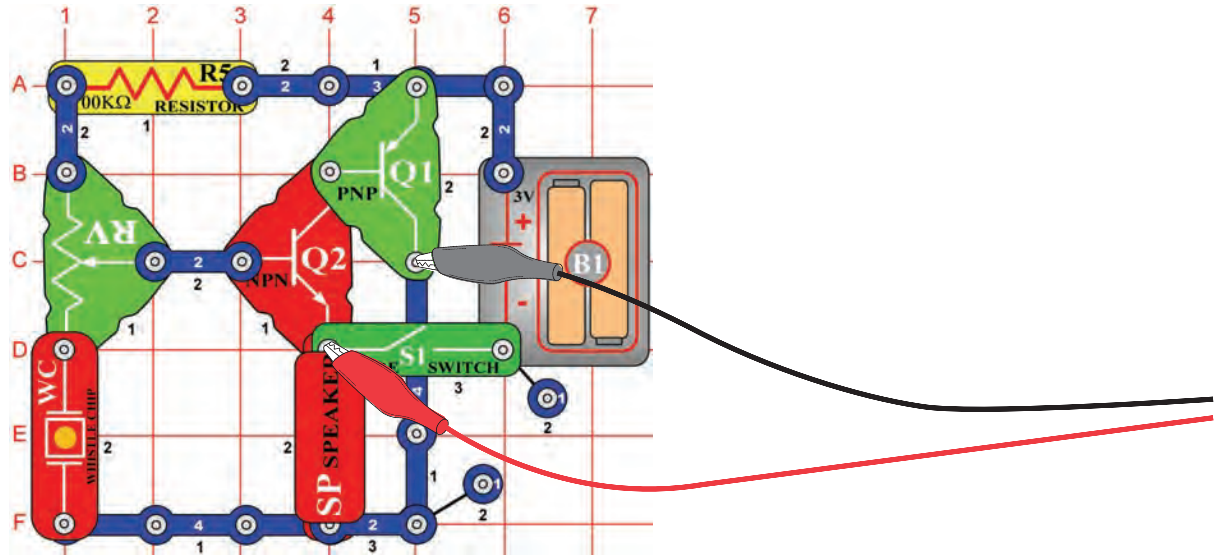


In this way you can show the peak energy achieved at each frequency. But this is only useful on a stable waveform, so if you move the adjustable resistor lever now the signal will fill the screen as the peaks move across the display.

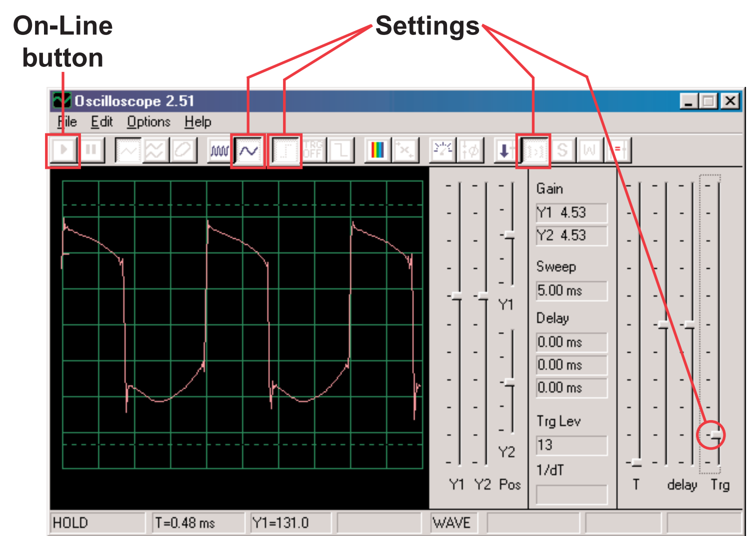
Most oscilloscopes and spectrum analyzers have a storage mode like this of some form.

Project #PC3 Hissing Foghorn PC

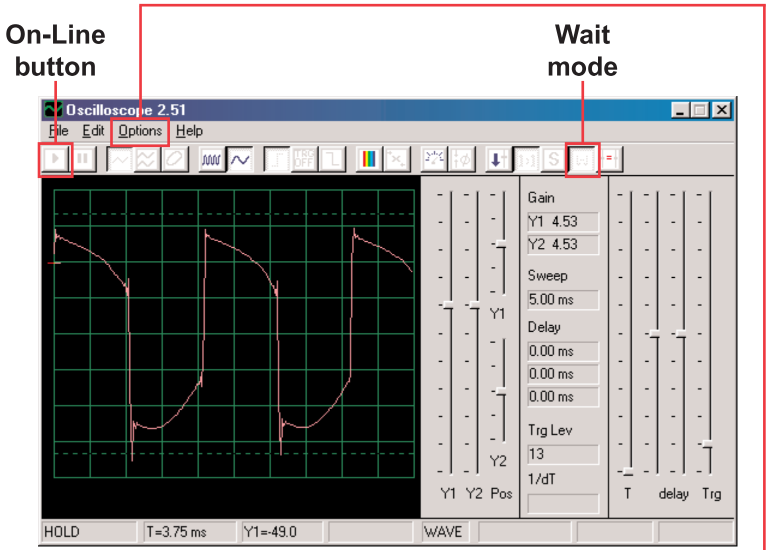
OBJECTIVE: To demonstrate wait mode with multiple colors.



Build the circuit shown. If continuing from the previous experiment then close the Winscope program and run it again, to reset the settings. Click on the **On-Line button** to activate, and turn on the switch (snap part S1). Set Winscope to the **settings** shown on the right, and move the lever on the adjustable resistor (snap part RV) around to change the waveform and the sound. At some positions there may be no sound. A sample waveform is shown here, but the pattern and shape of the pulses depends on the adjustable resistor setting.



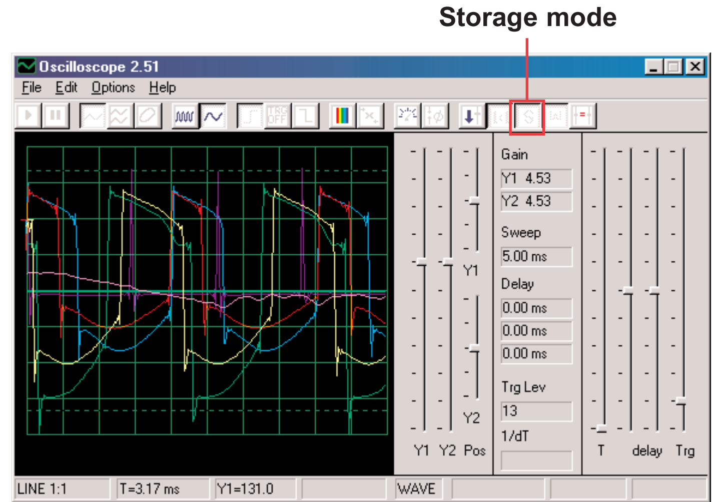
Place Winscope in **Wait mode** by clicking on the button for it, then slowly press the **On-Line button** several times. Now turn off the slide switch (snap part S1) and press On-Line again. Then turn the switch back on. You see that in Wait mode Winscope scans ("waits") until it sees a waveform that exceeds the trigger level you set, then stops. With a strong signal it will make one scan and then stop, whereas if no signal is present it keeps scanning until it finds one. You could use this to sense when someone has turned on the circuit.



You can change the color of the waveform: select **<Options>**, then select <Colors>, then select <Y1 Trace>. Now select the color you like and click <OK>.

Now we will combine the wait and storage modes to display several waveforms that this circuit can create. You should have the circuit on with the adjustable resistor at mid-range and Winscope in Wait mode. Now turn on **Storage mode**. Now change the color of the Y1 trace. Move the adjustable resistor control lever a little, then press On-Line once to record another waveform. Now change the color of Y1 again. Move the resistance control again and press On-Line once. Change the Y1 color, adjust the resistance and press On-Line. Change the Y1 color, adjust the resistance and press On-Line. Do this several more times if you like. Note that at some resistance settings there may be no waveform to trigger on, move the resistance control until it does.

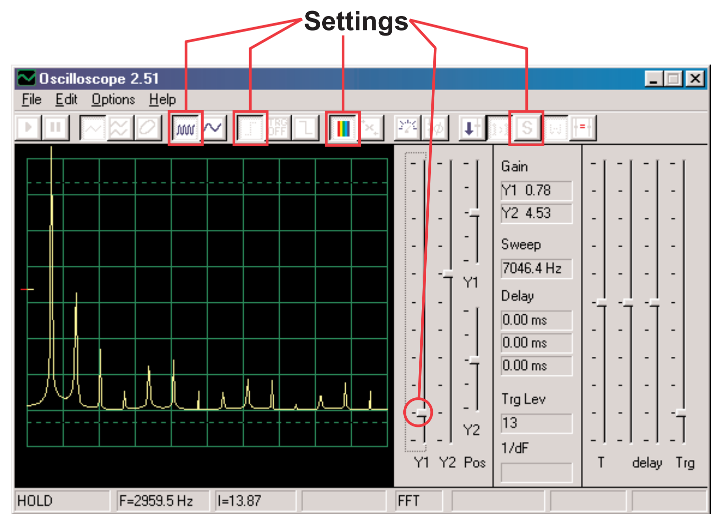
Now your display should look something like this:



Now you see the range of waveforms this circuit can create, all at the same time. Engineers often do this to compare signals during analysis.

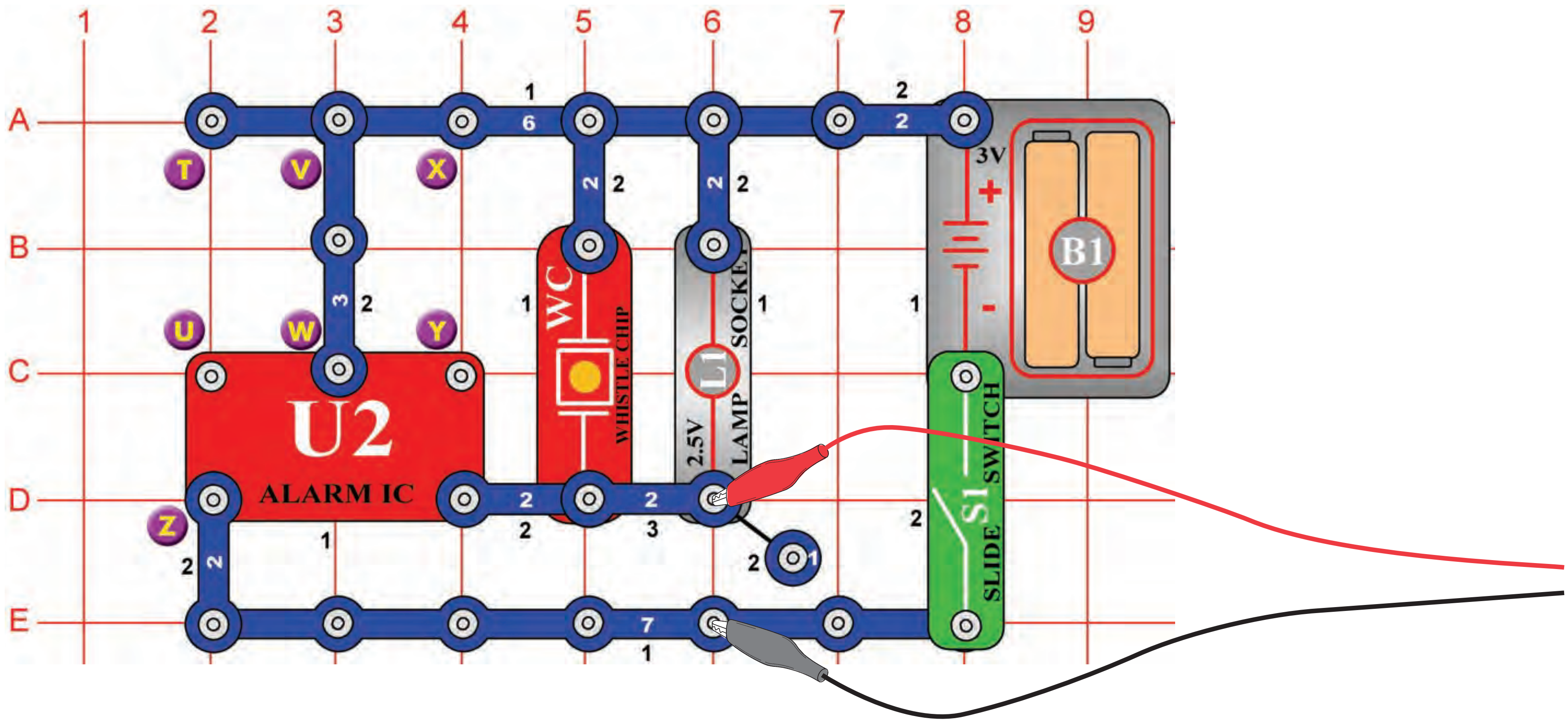
You can use Wait mode and different colors like this on the other circuits if you like.

Now turn off storage mode and turn on FFT mode to look at the frequency spectrum, try the **settings** shown here. Wait mode does not apply in FFT mode, so it has no effect here. Moving the adjustable resistor lever will change the spectrum shown.



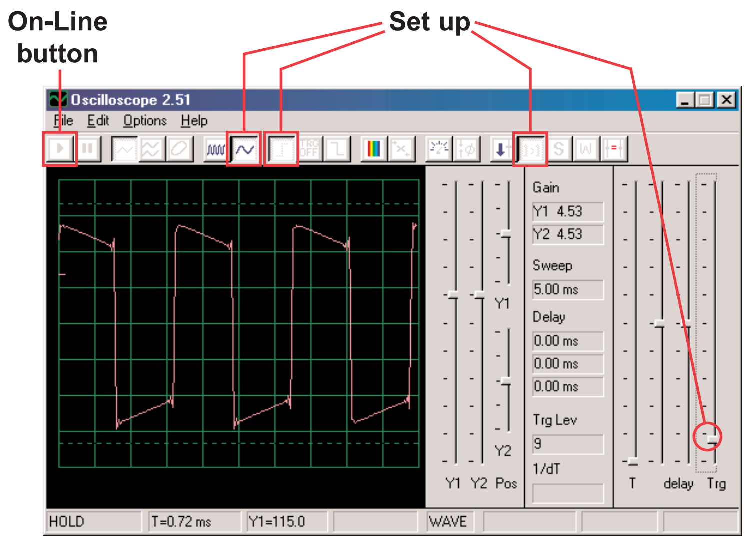
Project #PC4 Light & Sounds PC

OBJECTIVE: To look at the output signal from a circuit that makes alarm sounds.



Build the circuit and connect the Winscope PC-interface cable as shown, the cable should still be connected to the microphone input on your computer.

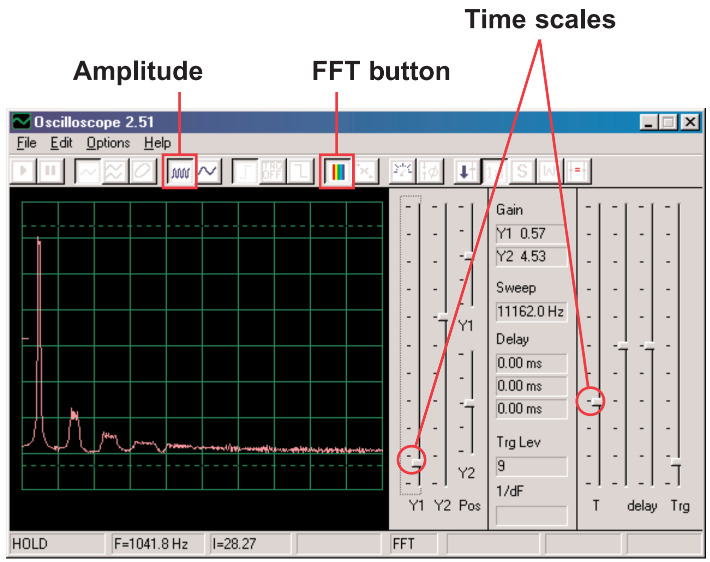
If continuing from the previous experiment then close the Winscope program and run it again, to reset the settings. Then use the mouse to **set it up** as shown here, and turn on the switch (snap part S1). Click on the **On-Line button** to activate.



You should see a waveform similar to that shown here, but it will be constantly changing. This is because the siren sound you hear is not a continuous tone but instead is constantly changing. Note the differences in the waveshape for this circuit compared to the circuit in Project PC1.

Your picture may appear different due to variations in the microphone input designs between computers. See the notes on page 4 for details.

Click on the **FFT button** to look at the frequency spectrum. Also set the **amplitude** and **time scales** (really amplitude and frequency scales in FFT mode) to be as shown here.



You should see a fuzzy spectrum similar to that shown here, but it will be constantly changing. This is because the siren sound you hear is not a continuous tone but instead is constantly changing frequency, and it spends more time at some frequencies than at others. Note the differences in the spectrum for this circuit compared to the circuit in Project PC1.

☐ Project #PC5

Light & Sounds PC (II)

Modify the circuit for project PC4 by connecting points X and Y on the snap diagram. Now the sound is a machine gun, it shuts off between bursts.

Look at the waveform and frequency spectrum using the same settings as for project PC4, and compare them to those for the siren.

☐ Project #PC6

Light & Sounds PC (III)

Modify the circuit by removing the connection between X and Y and then make a connection between T and U. It makes a fire engine sound.

Look at the waveform and frequency spectrum using the same settings as for project PC4. The waveform slowly rises and falls in pitch, and gives a clear spectrum that slowly rises and falls in frequency.

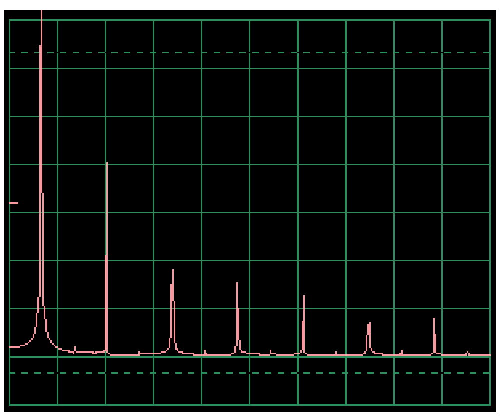
☐ Project #PC7

Light & Sounds PC (IV)

Remove the connection between T and U and then make a connection between U and Z. It makes an ambulance sound.

Look at the waveform and frequency spectrum using the same settings as for project PC4. It alternates between two frequencies.

Sample Frequency Spectrum



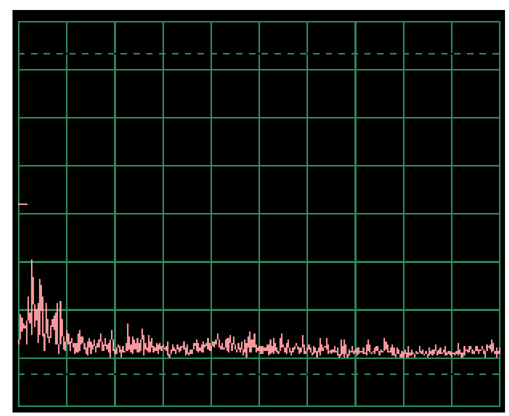
☐ Project #PC8

Light & Sounds PC (V)

Remove the connections between U and Z and between V and W, then make a connection between T and U. It makes a water faucet sound.

Look at the waveform and frequency spectrum using the same settings as for project PC4. This sound is different from the others and seems to have little or no pattern.

Sample Frequency Spectrum

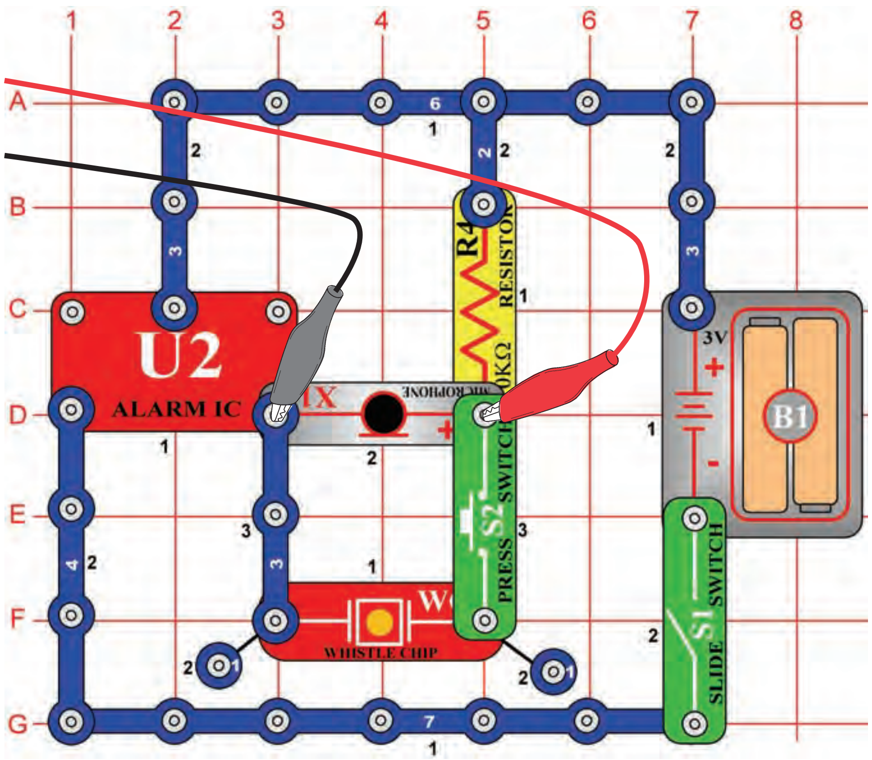


☐ Project #PC9
Light & Sounds PC (VI)

Look at the waveform in oscilloscope mode using the same settings as earlier in PC4. Replace the whistle chip with the speaker and remove the lamp. Compare the waveform you see now with that from the whistle chip. The amplitude of the waveforms are similar but yet the sound from the speaker is much louder, since the speaker is drawing more current.

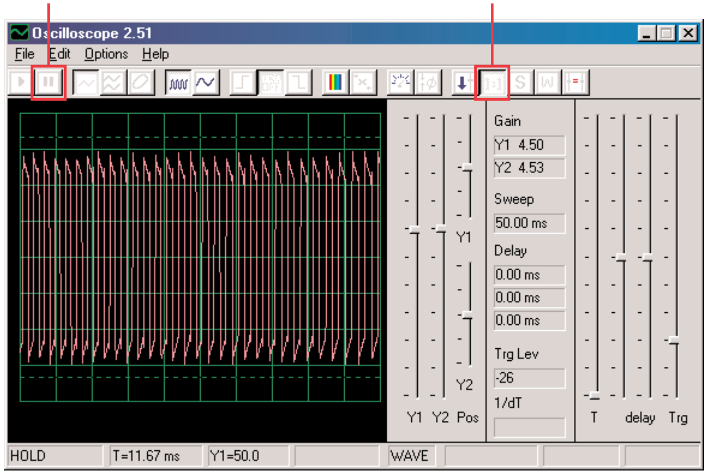
☐ Project #PC10
Modulation

OBJECTIVE: To demonstrate AM and FM modulation.

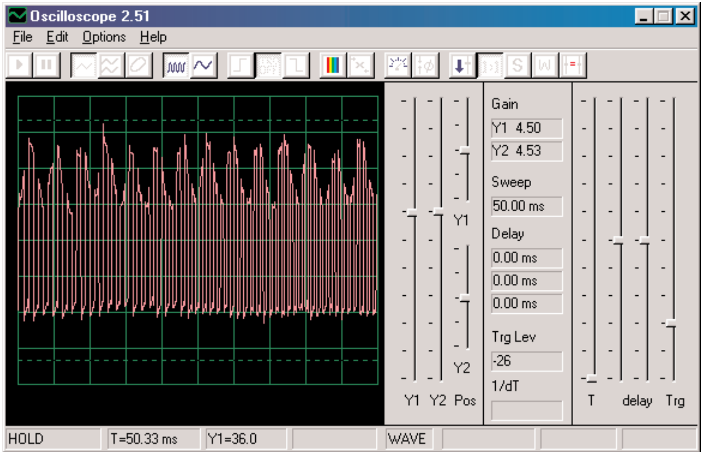


Build the circuit shown. If continuing from the previous experiment then close the Winscope program and run it again, to reset the settings. Click on the On-Line button to activate, and turn on the switch (snap part S1). If you press the key (snap part S2) then you will hear a siren sound, but it will not be very loud. Click on the **1:1 button** to set the gain automatically, then talk or hum into the microphone (snap part X1) and observe how the waveform changes. You may freeze the waveform by pressing the **Hold button** if desired.

Hold button **1:1 button**

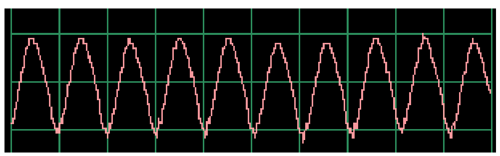


When you are quiet you just get a stream of pulses with roughly equal height and width, as shown at left.

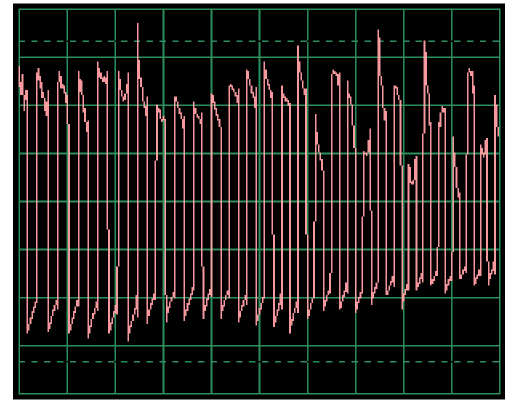


The waveform shown here is from humming into the microphone, notice how the tops of the pulses show a regular pattern of dips now.

Look ahead to the Microphone project PC14 on page ??, and note the waveform shown there for humming into the microphone:



Notice that you can see roughly the same pattern in the peaks of the waveform at left. If you hum at a similar tone and at a similar distance from the microphone, you will get similar results.

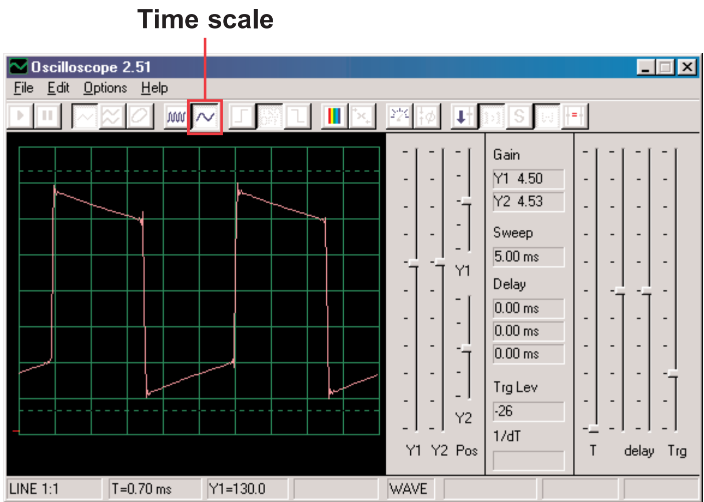


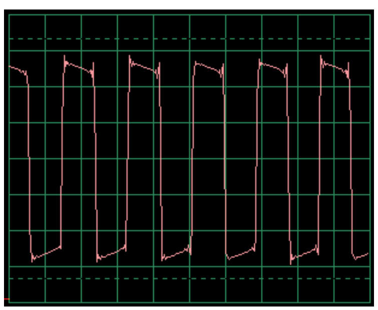
If you talk into the microphone now you will get different patterns depending on what words you say, how loudly you say them, and your distance from the microphone. Words produce a more "random" pattern than humming, but less random than blowing into the microphone. The waveform at left is an example of talking into the microphone. Observe the waveforms you get and compare with what you get in project PC14.

And so you see that your voice is being superimposed onto the peaks of the stream of pulses, this is called **Amplitude Modulation** or **AM**. At AM radio stations music or voice is superimposed on a high frequency waveform (similar to the pulse stream here), filtered, amplified, and transmitted. Doing this allows the music to be transmitted over great distances.

You can place Winscope into FFT mode to view the frequency spectrum if you like, but it will be confusing to look at.

You probably noticed that the width of the pulses in the pulse stream is constantly changing, that is because there is actually a second type of modulation occurring here. Press the key again and you hear a siren. A siren is not a stable tone but rather is constantly changing in frequency. Change the **time scale** to 0.5ms/div and observe the range of waveforms:



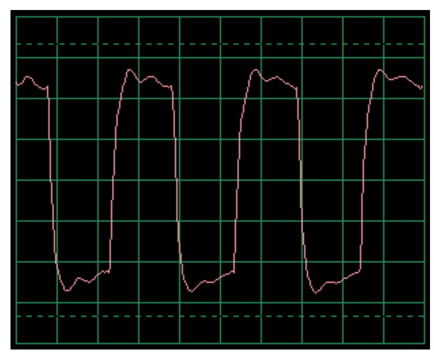


The width of the pulses (or frequency of the signal) is slowly being changed, at a regular and repetitive rate. This is an example of **Frequency Modulation**, or **FM**. In AM you use a controlling signal (voice or music) to vary the amplitude of a second signal, in FM you use the controlling signal to vary the frequency of the other signal. In this circuit the output frequency from the alarm IC is being controlled by a signal created inside the alarm IC, but it could have been controlled by humming like you did for the AM (you don't have the parts needed to do this).

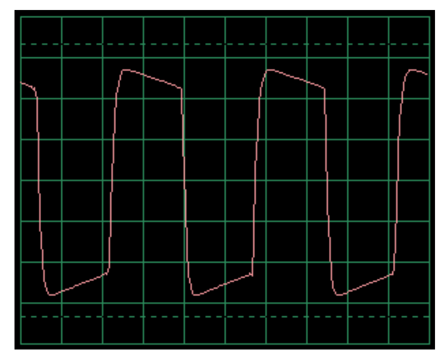
Look back at the Light & Sounds project PC4 on page 16. It shows several different ways of configuring the alarm IC to make different sounds, all of these are examples of frequency modulation using different controlling signals created within the alarm IC. It also shows examples of the frequency spectrum.

☐ Project #PC11 Filtering

With the same circuit as PC10 and the same settings as shown at the end of PC10, look at the waveform again and then press the key. Notice how the pulses become more "rounded" when the key is pressed. The whistle chip (snap part WC) has capacitance that filters or smoothes the output signal. Now replace the whistle chip with the 0.02μF capacitor (snap part C1) and it should look similar though you won't hear any sound. You can also look at the frequency spectrum in FFT mode like in the other projects.



Typical waveform using whistle chip

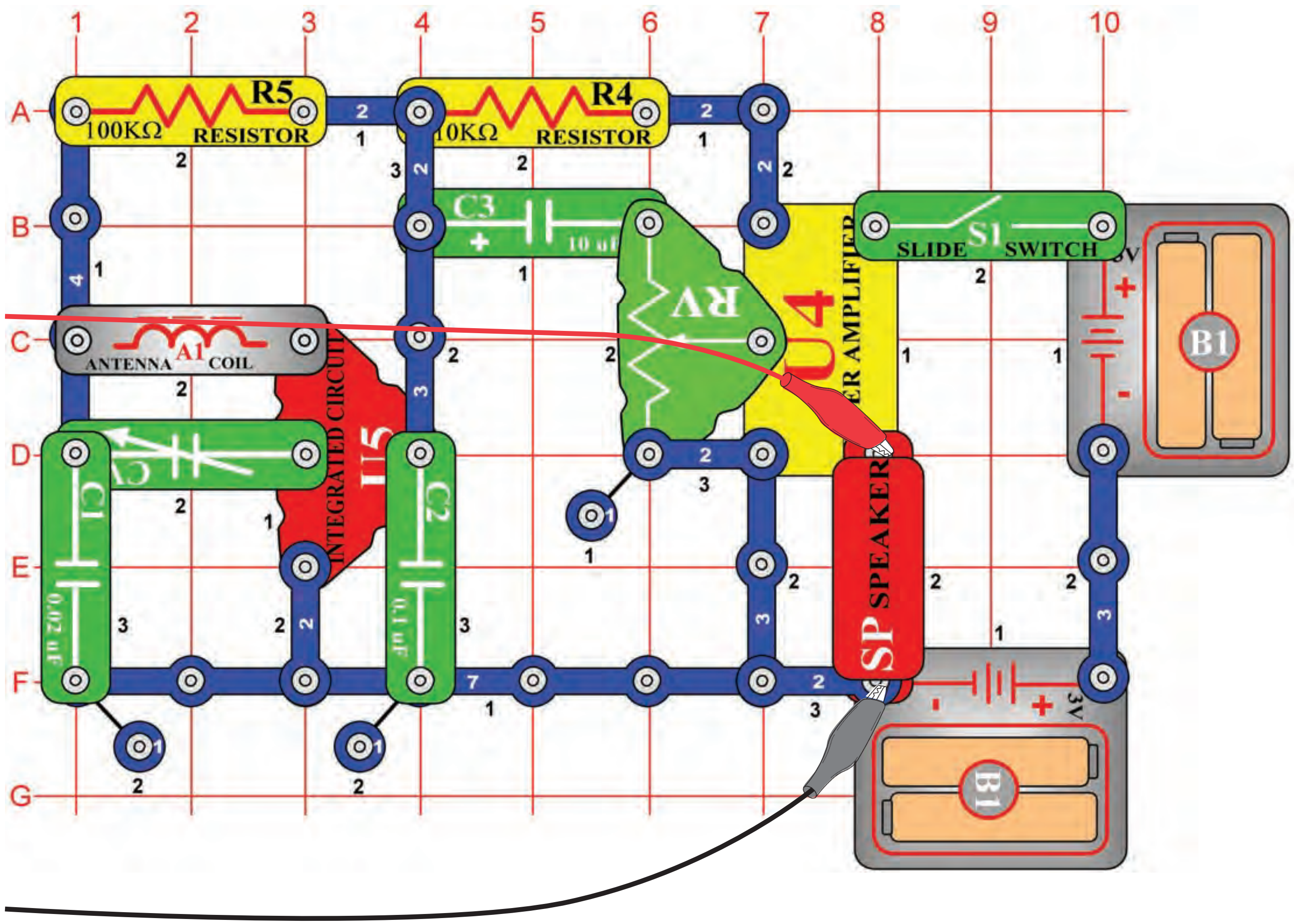


Typical waveform using 0.02μF capacitor

Project #PC12

AM Radio PC

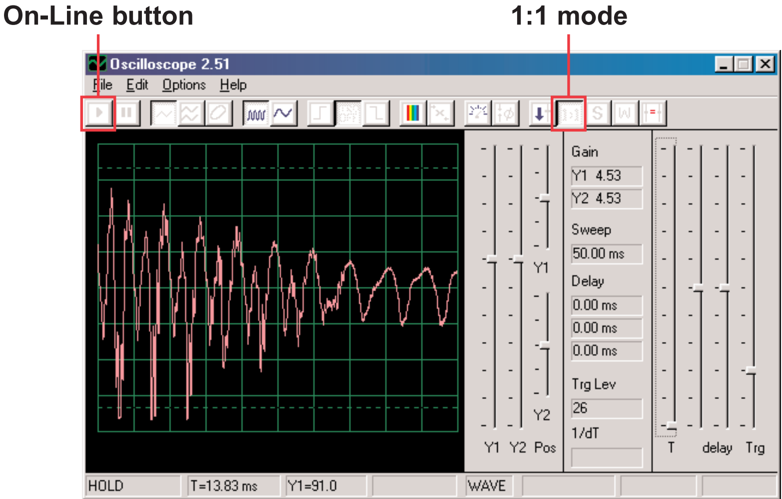
OBJECTIVE: To look at the output signal from an AM radio.



Build the circuit shown and connect the PC-interface cable to the microphone input on your computer. Turn on the slide switch (snap part S1), tune the variable capacitor (snap part CV) to a local radio station that gives good reception, and set the adjustable resistor (snap part RV) to a comfortable volume. The integrated circuit (snap part U5) detects and amplifies the AM radio waves all around you. The power amplifier IC (snap part U4) drives the speaker (snap part SP) to complete the circuit.

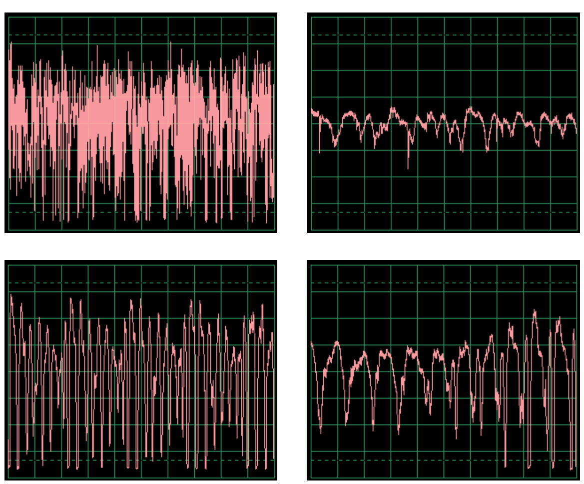
In this project you will study the audio signal at the radio's output to the speaker. The actual AM radio transmission is at high frequencies that cannot be viewed using Winscope.

If continuing from the previous experiment then close the Winscope program and run it again, to reset the settings. Then use the mouse to set the scale to **1:1 mode**. Click on the **On-Line button** to activate.

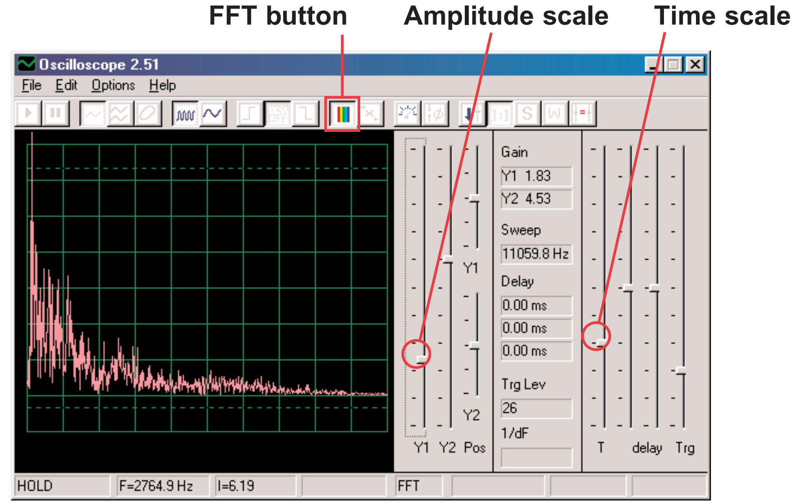


You should see a waveform similar to that shown here, but it will be constantly changing as the music or talking you hear is changing. Try tuning the adjustable capacitor (snap part CV) to different radio stations and compare the waveforms.

This shows you what talking or music look like in electrical form. Every word that every person says looks different, though there are many patterns. The waveform will be fuzzier if there is lots of static on the station. Here are some other examples of talking and music using the same settings above:

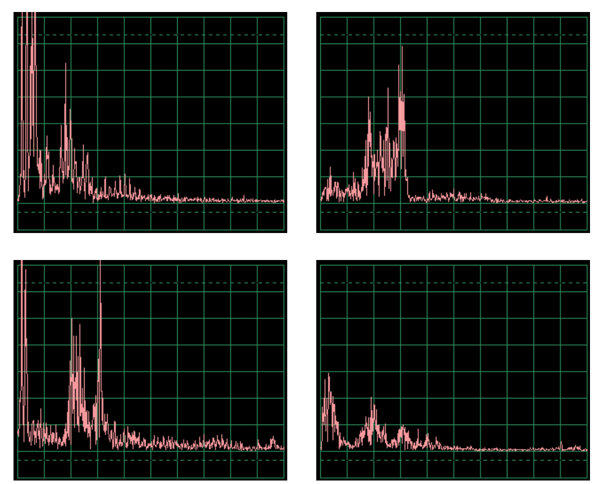


Click on the **FFT button** to look at the frequency spectrum. Set the **time scale** (really frequency scale in FFT mode) and **amplitude scale** to be as shown here.



You should see a spectrum similar to that shown here, but it will be constantly changing as the music or talking you hear is changing. Try tuning the adjustable capacitor (snap part CV) to different radio stations and compare the waveforms.

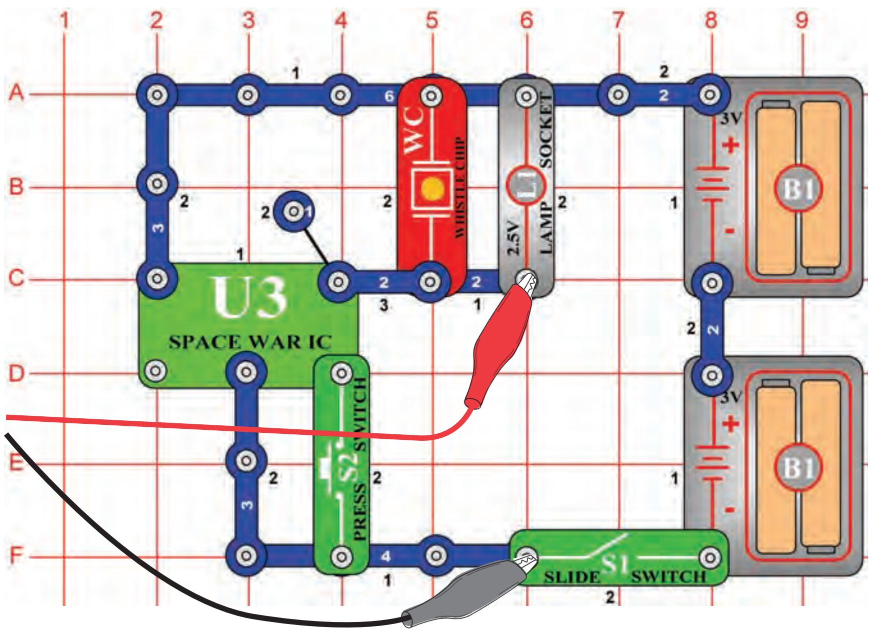
This shows you the frequency spectrum of talking or music. Every word that every person says looks different, though there are many patterns. The spectrum will be fuzzier if there is lots of static on the station. Here are some other examples of talking and music using the same settings above:



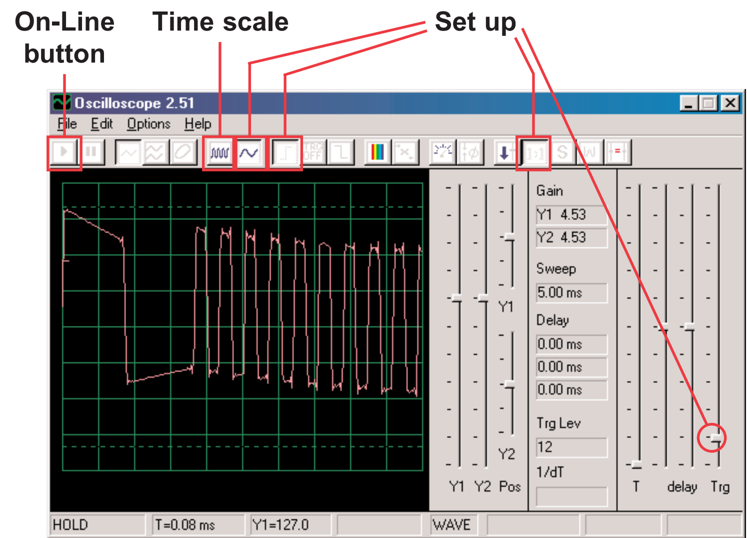
☐ Project #PC13
Space War PC

OBJECTIVE: To look at the output signal from a circuit that makes space war sounds.

Build the circuit shown and connect the PC-interface cable to the microphone input on your computer.

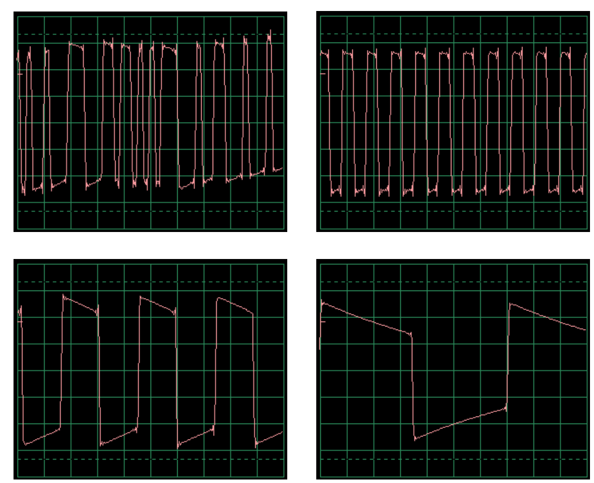


If continuing from the previous experiment then close the Winscope program and run it again, to reset the settings. Then use the mouse to **set it up** as shown here, and turn on the switch (snap part S1). Click on the **On-Line button** to activate.

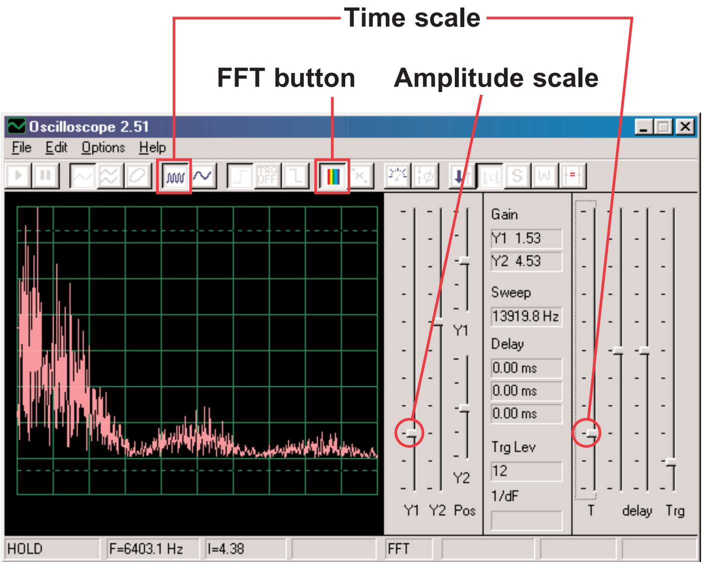


Press the press switch (snap part S2) several times to step through the eight different sounds from the space war integrated circuit. Hold it down for a few seconds each time so you can see the waveform representing the sound you hear.

It is also interesting to switch to the **5ms/div time scale** setting to see more of the waveform at one time. Here are some example waveforms using the same settings as above:

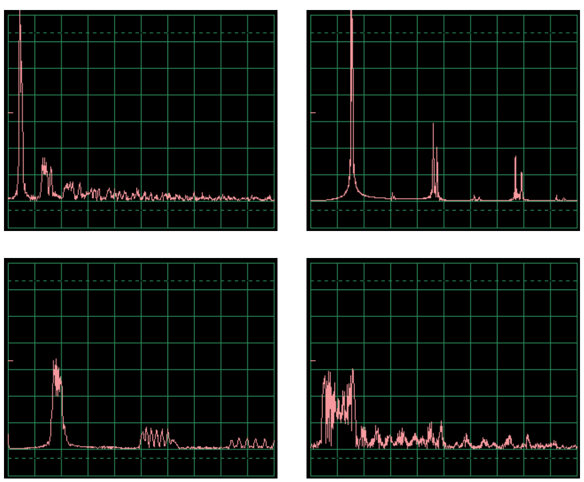


Click on the **FFT button** to look at the frequency spectrum for these signals. For best viewing set the **amplitude** and **time scales** (really amplitude and frequency scales in FFT mode) to be as shown here.



Press the press switch (snap part S2) several times to step through the eight different sounds from the space war integrated circuit. Hold it down for a few seconds each time so you can see the frequency spectrum representing the sound you hear.

Here are sample spectrums from some of the other sounds using the same settings as above:

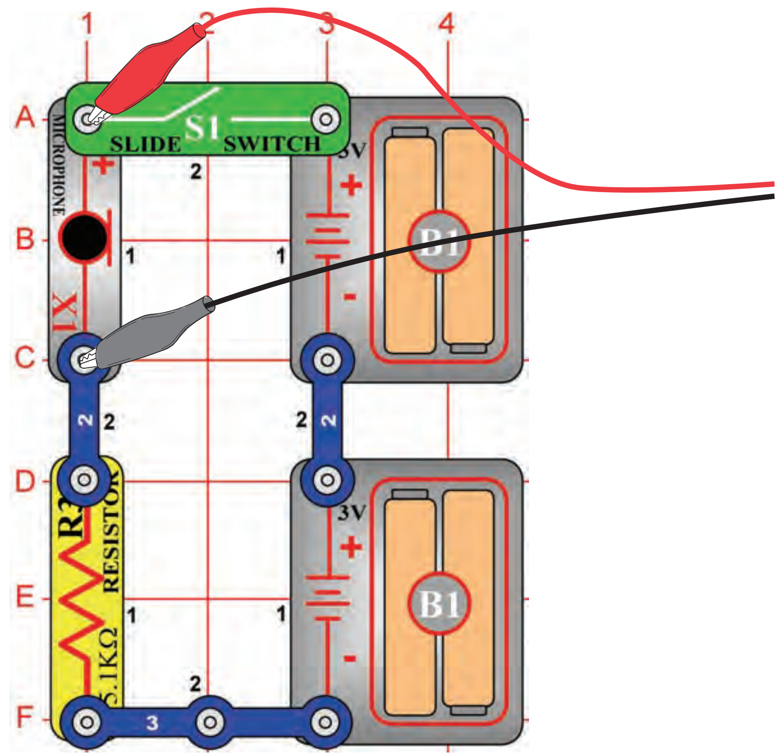


Project #PC14

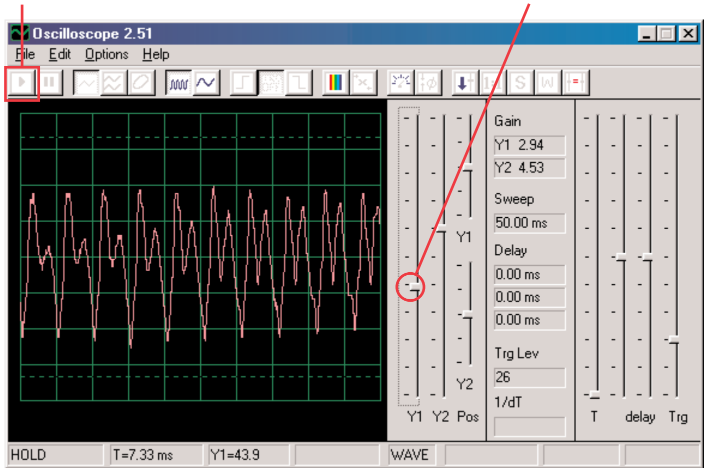
Microphone

OBJECTIVE: To see what your voice looks like in electrical form.

Build the circuit shown and connect the PC-interface cable to the microphone input on your computer.

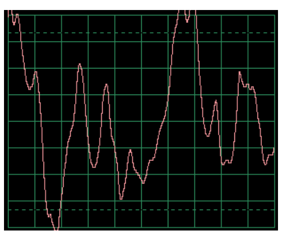


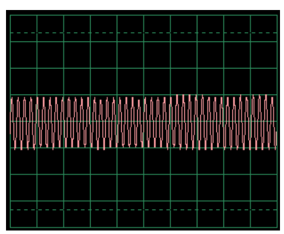
If continuing from the previous experiment then close the Winscope program and run it again, to reset the settings. Click on the **On-Line button** to activate Winscope, and turn on the switch (snap part S1).

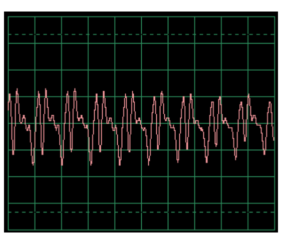


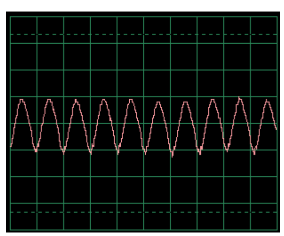
Talk into the microphone (snap part X1) and see what your voice looks like after the microphone converts it to electrical energy. Adjust the **Y1 gain control** to get the best view of it, since the amplitude is greater if you talk louder or are closer to the microphone. Notice how the waveform is different depending on which words or tones you say.

Here are some example waveforms using the same settings as above. Try not to blow on the microphone while you talk into it.

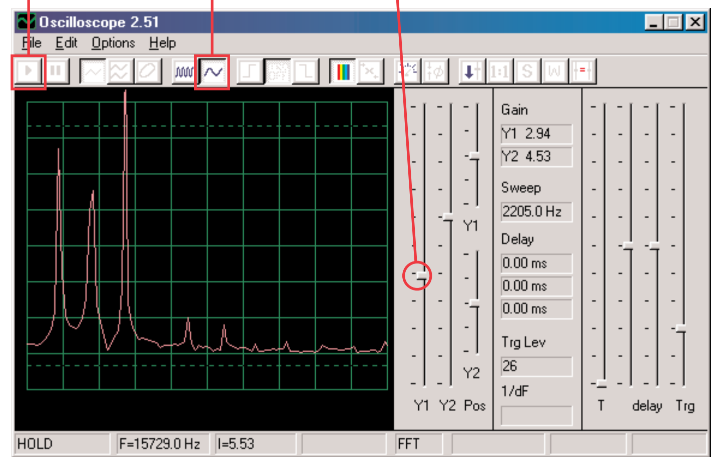

Blowing into microphone


Whistling into microphone


Ahhhhhh sound

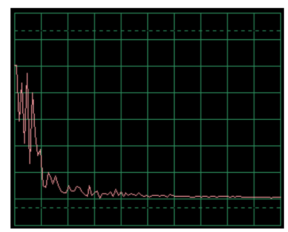

Humming into microphone

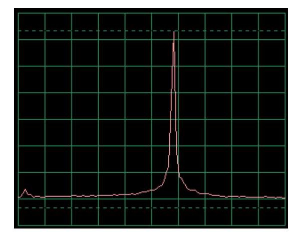
Click on the **FFT button** to look at the frequency spectrum for these signals. Try the **amplitude** and **time scales** shown here to start, but your best settings will depend on what sounds you make, how loud you speak, and how close you are to the microphone.

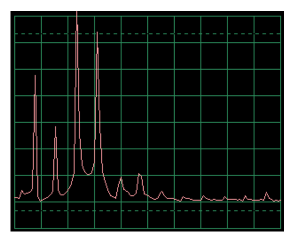


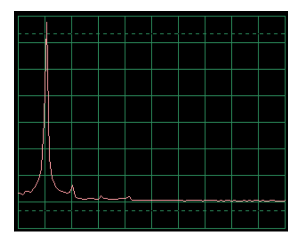
Notice that most women have higher-frequency voices than most men, and so their frequency peaks are further to the right on your display.

Here are some example waveforms using the same settings as above:


Blowing into microphone


Whistling into microphone


Ahhhhhh sound

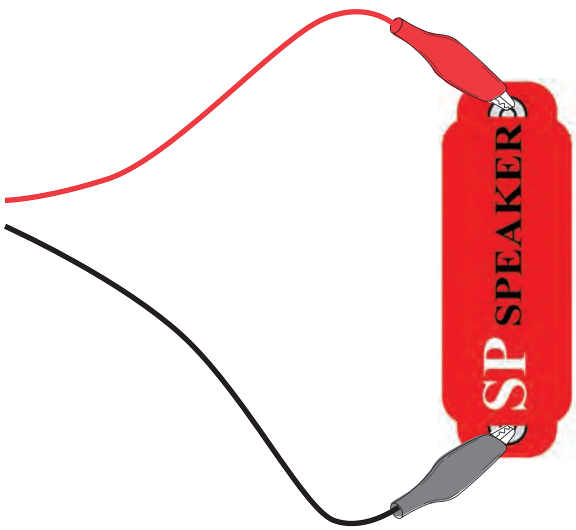

Humming into microphone

The above frequency spectrum pictures correspond directly to the waveform pictures on the preceding page. Notice that the spectrums for the hum and whistle have only a single big peak. Smooth, well-rounded, and repetitive waveforms (in oscilloscope mode) have nearly all of their energy at a specific frequency like for the hum. "Square" or "rectangular" looking waveforms (like in Project PC1) and most music have a series of mathematically-related peaks, while "random" waveforms (like from blowing into the microphone or several people talking at the same time) have a frequency "blob" instead of distinct peaks.

☐ Project #PC15

Speaker Microphone

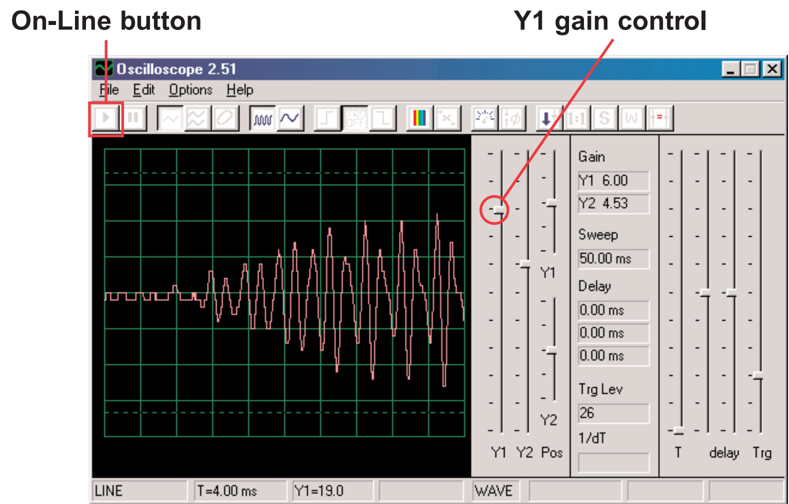
***OBJECTIVE:* To see what your voice looks like in electrical form.**



A speaker uses electrical energy to create mechanical vibrations. These vibrations create variations in air pressure, called sound waves, which travel across the room. You "hear" sound when your ears feel these air pressure variations. But if air pressure variations reach the speaker from another source, they will cause it to vibrate too. This, in turn, causes the speaker to create a small electrical signal just like a microphone does (though not very efficiently, since speakers were not designed to be microphones).

Connect the PC-interface cable directly onto the speaker as shown; no other parts are needed here. If continuing from the previous experiment then close the Winscope program and run it again, to reset the settings. Click on the **On-Line button** to activate.

Hold the speaker next to your mouth and talk into it to see what your voice looks like after the speaker converts it to electrical energy. Adjust the **Y1 gain control** to get the best view of it.



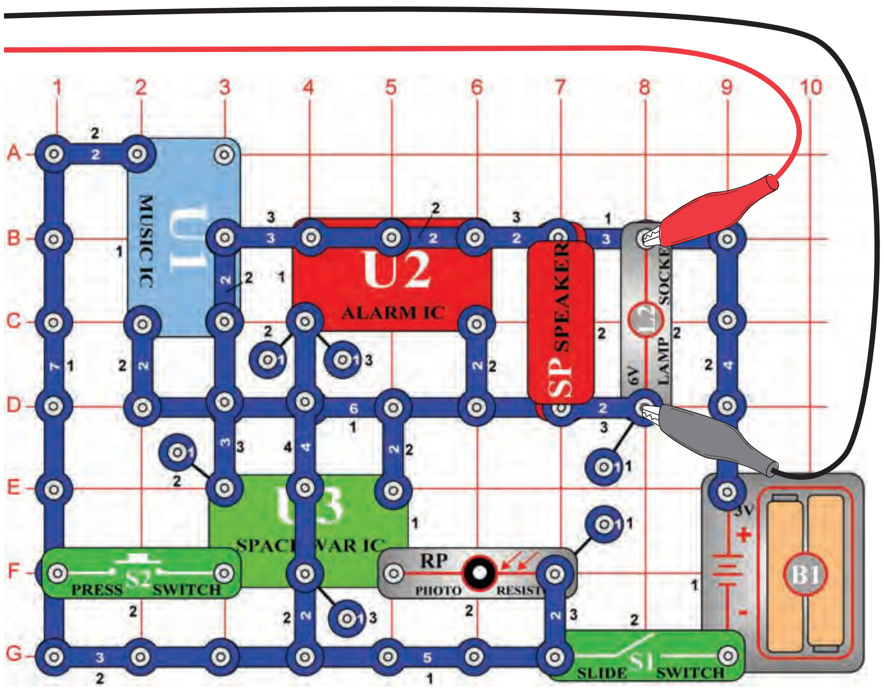
Notice that you need to set the gain control higher here than in the preceding project using the microphone, since speakers were not designed to be used in the same way.

You may switch to FFT mode and view the frequency spectrum in the same manner as for the microphone project PC14.

☐ Project #PC16

Symphony of Sounds PC

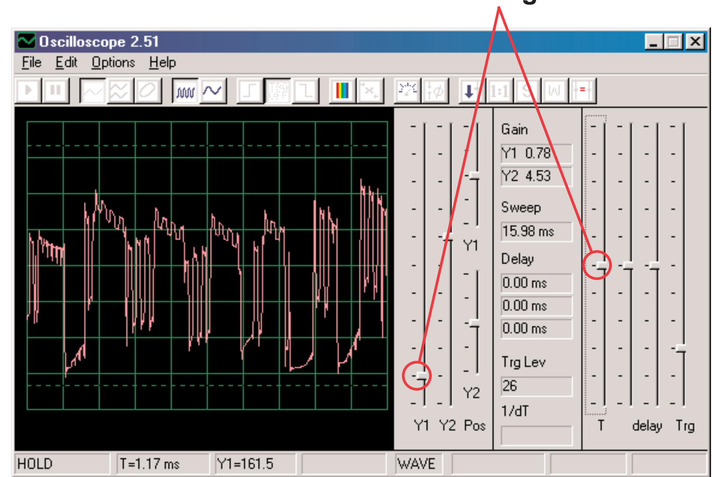
OBJECTIVE: To see the waveforms for a complex signal.



The Symphony of Sounds project combines waveforms from the Music, Alarm, and Space War integrated circuits. Build the circuit shown. If continuing from the previous experiment then close the Winscope program and run it again, to reset the settings. Click on the On-Line button to activate, and turn on the switch (snap part S1). Press the press switch (S2) and wave your hand over the photosensitive resistor (RP).

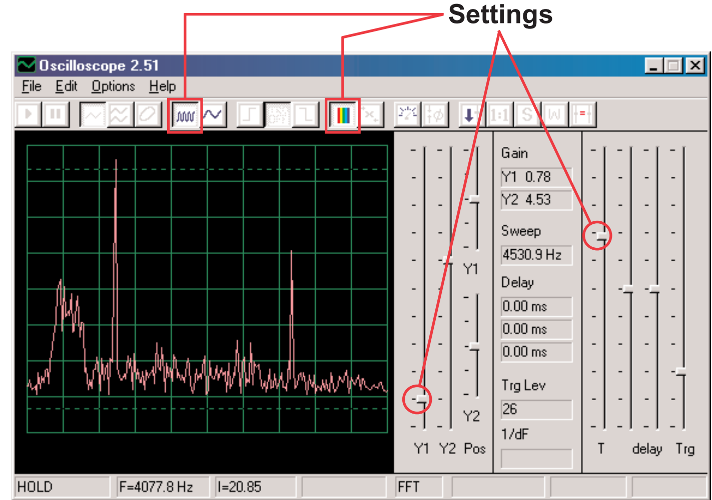
Due to the combination of sounds, the waveform is complex. Set Winscope to the **settings** shown, or as you prefer.

Settings



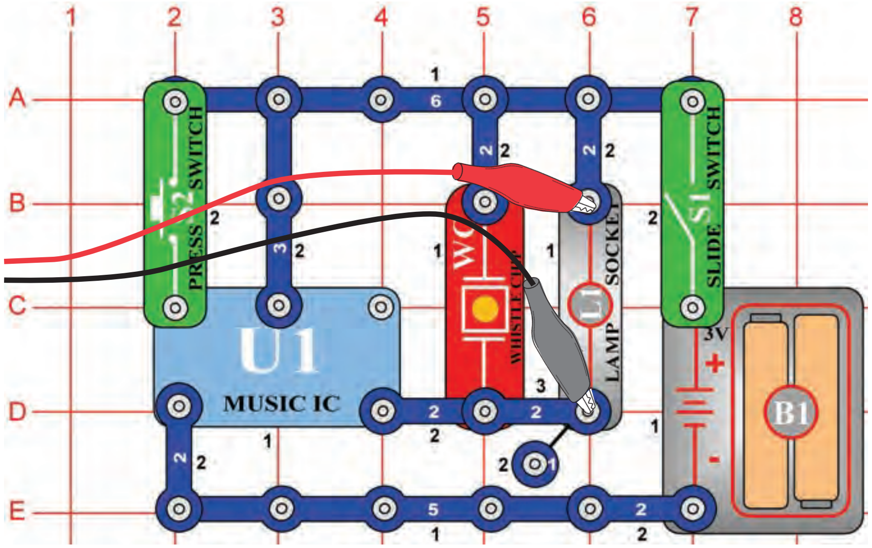
Click on the FFT button to look at the frequency spectrum for the signal. Try the **settings** shown here, or as you prefer.

Settings

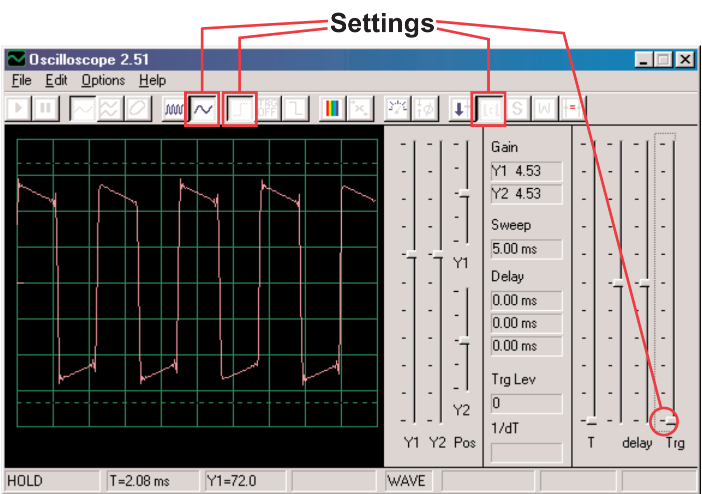


☐ Project #PC17
Doorbell PC

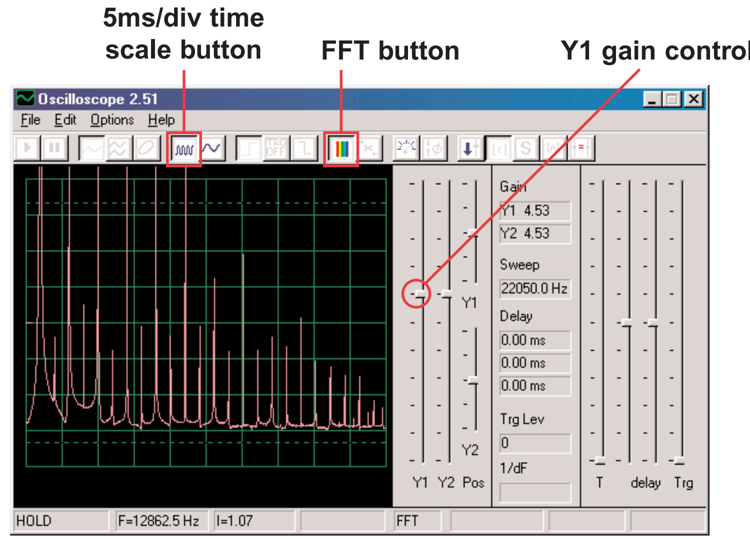
OBJECTIVE:* *To look at the output of a musical circuit.



Build the circuit shown. If continuing from the previous experiment then close the Winscope program and run it again, to reset the settings. Click on the On-Line button to activate, and turn on the slide switch (snap part S1). Try the **settings** shown here. When the music stops, press the press switch (part S2) and it will resume.



Click on the **5ms/div time scale button** and on the **FFT button** to look at the frequency spectrum for the signal. The Y1 gain control is set for high gain now, so the higher peaks are off the screen but lots of the lower peaks are visible.

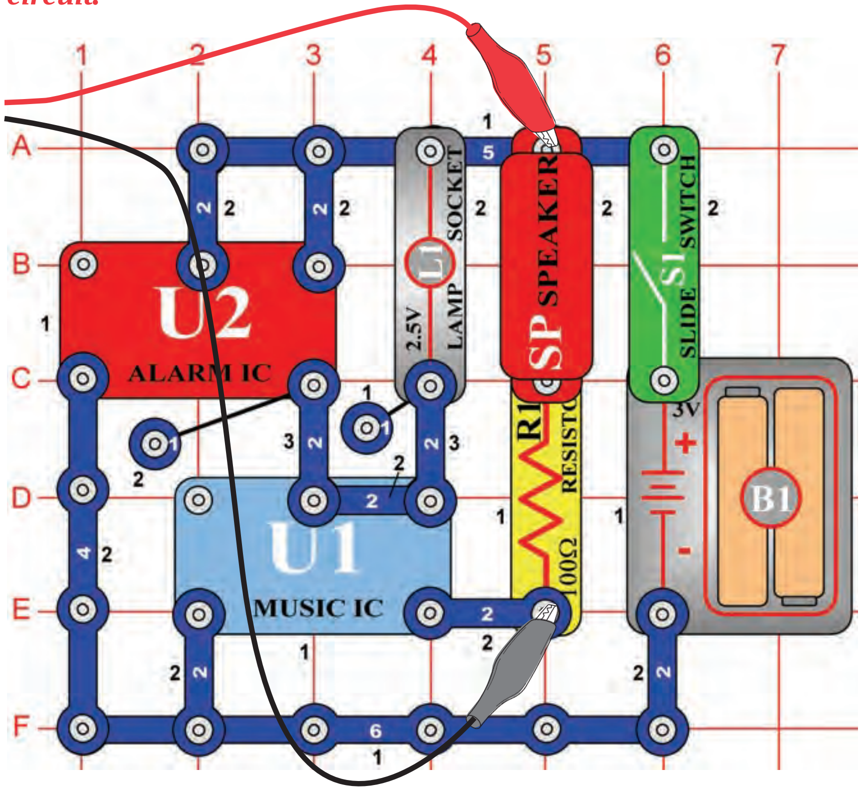


Note that the sound is music and the oscilloscope waveform has a "square" shape, as a result the frequency spectrum has a lot of peaks with equal spacing.

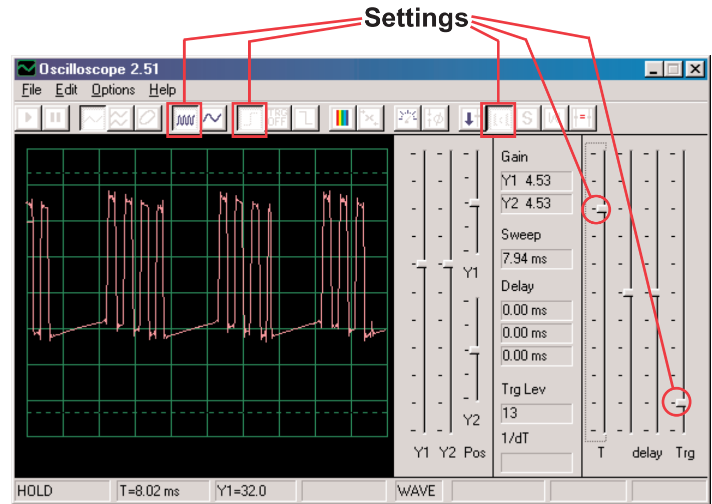
Now adjust the **gain** lower until you see the higher peaks.

☐ Project #PC18
Periodic Sounds PC

***OBJECTIVE:** To look at the output of an alternately changing circuit.*

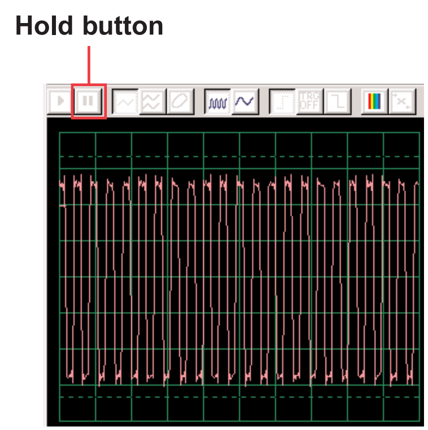


Build the circuit shown. If continuing from the previous experiment then close the Winscope program and run it again, to reset the settings. Click on the On-Line button to activate, and turn on the slide switch (snap part S1). Try the **settings** shown here.

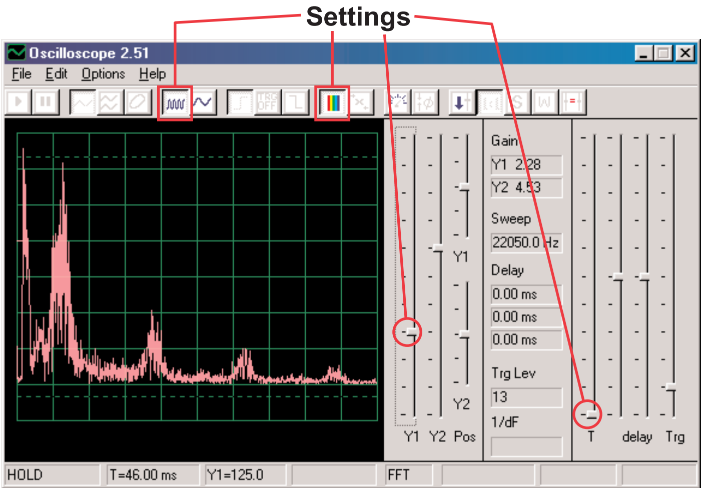


The oscilloscope display alternates between 2 waveforms, the one shown here and the one on the next page. This one shows some pulses followed by a flat signal, then more pulses, then flat, then pulses, then flat . . .

This is the second oscilloscope waveform, using the same settings. It is a continuous series of pulses. You can use the **Hold button** to freeze the display for easier viewing.

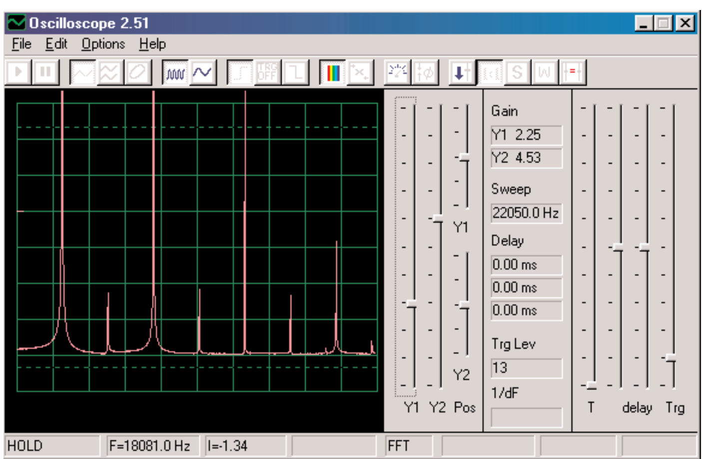


Now change to FFT mode to look at the frequency spectrums corresponding to the 2 waveforms above. Try the **settings** shown here.



This is the spectrum for the oscilloscope waveform shown on the preceding page, which alternates between pulses and flat. Because of the transition between pulses and flat, the spectrum is the irregular shape shown here.

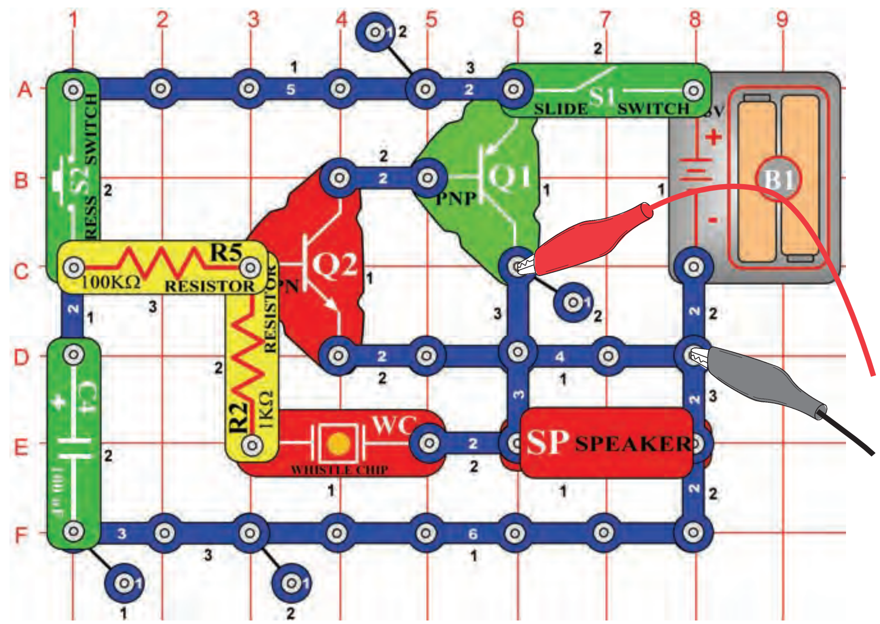
This is the spectrum for the oscilloscope waveform shown at the top of this page, which has a continuous series of pulses. There are only pulses there, with no transition between pulses and flat. Hence the frequency spectrum is very "clean", with the energy concentrated at a few tall peaks instead of being spread out like in the other spectrum display.



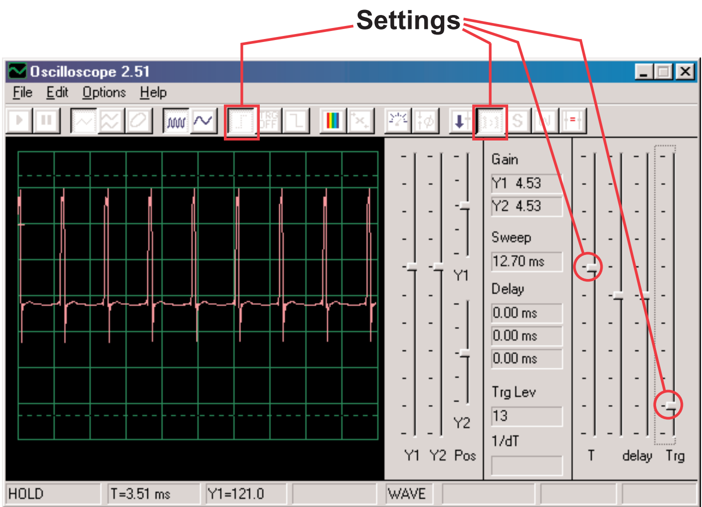
☐ Project #PC19

Lasting Doorbell PC

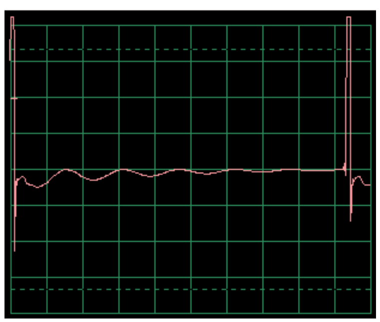
OBJECTIVE: To look at the output of an alternately changing circuit.



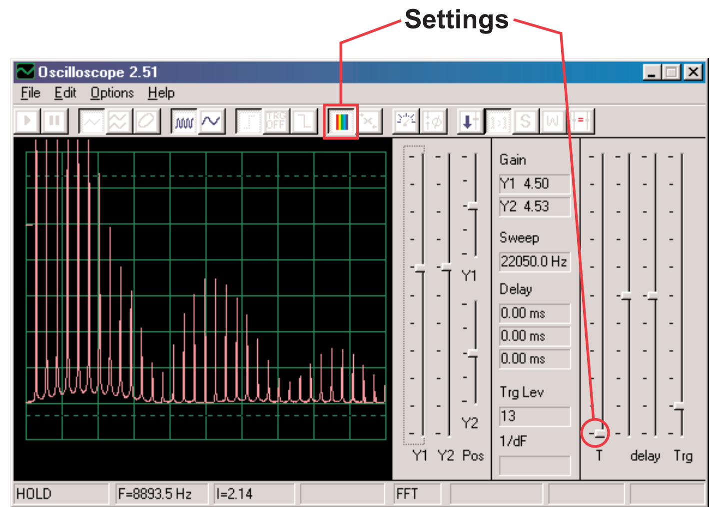
Build the circuit shown. If continuing from the previous experiment then close the Winscope program and run it again, to reset the settings. Click on the On-Line button to activate, turn on the switch (snap part S1), and press the press switch (part S2). Try the **settings** shown here.



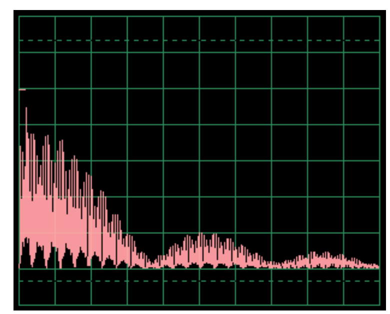
The waveform at left shows the signal just after pressing the press switch, the waveform below uses the same settings and shows the waveform just before the sound stops. You see the pulses slowly spread out as the tone of the sound changes.



Now change to FFT mode to look at the frequency spectrum as the sound fades away. Try the **settings** shown here.



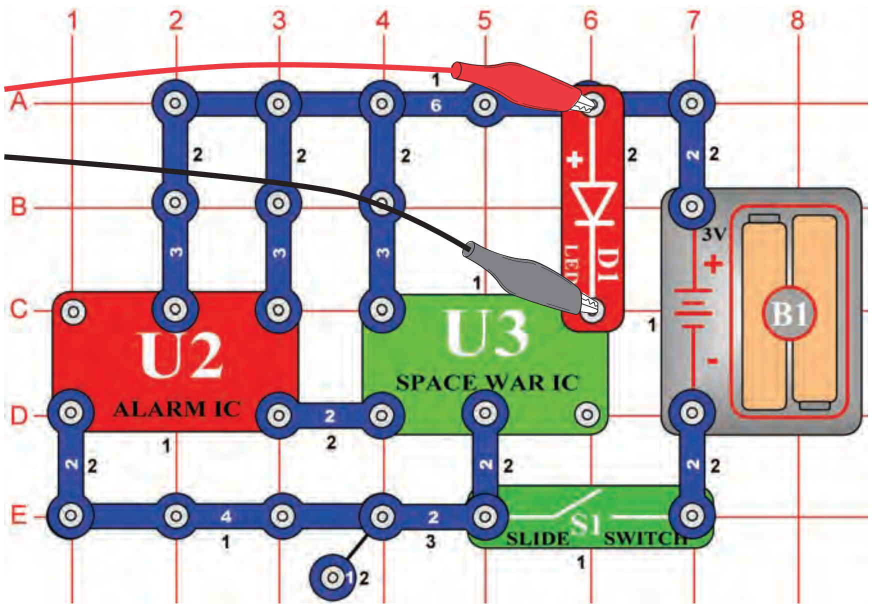
The spectrum at left is for just after pressing the press switch. The spectrum below uses the same settings and shows the spectrum just before the sound stops. The frequencies and amplitude slowly get lower as the sound fades away.



☐ Project #PC20

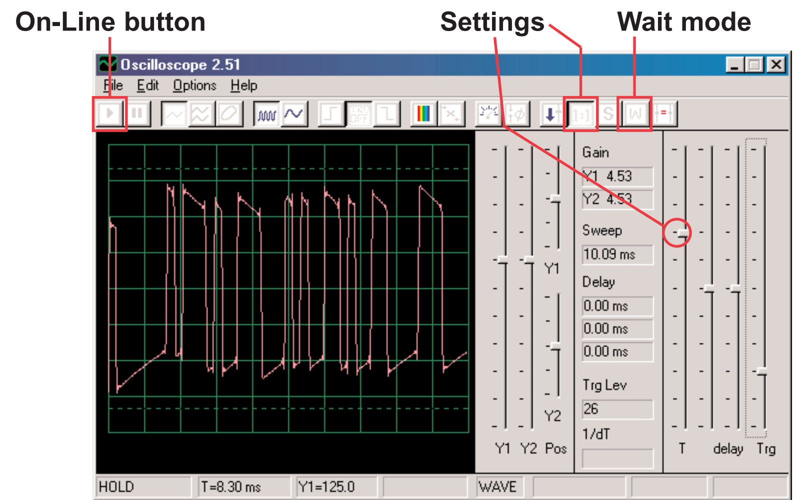
Space War Flicker PC

***OBJECTIVE:** To continuously show the patterns created by the space war IC.*



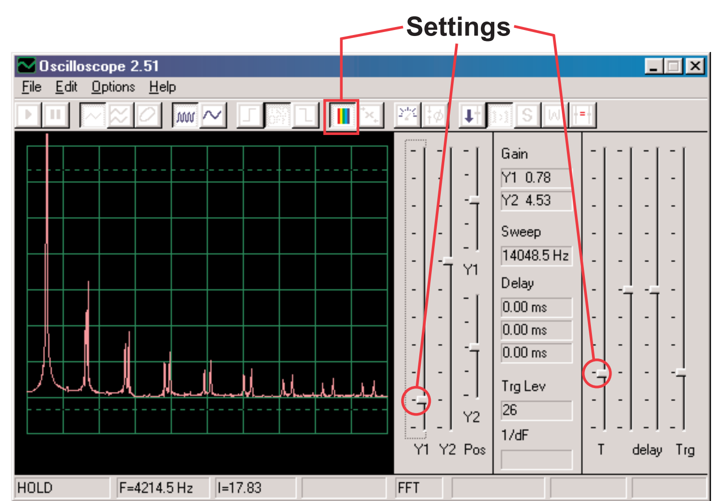
Build the circuit shown. If continuing from the previous experiment then close the Winscope program and run it again, to reset the settings.

Click on the **On-Line button** to activate, and turn on the switch (snap part S1). Set Winscope to the **settings** shown below. The signal from the alarm IC (snap part U2) causes the space war IC (part U3) to step through the 8 different patterns it can create. A sample waveform is shown here.



You can also activate **Wait mode** and press the On-Line button several times to view one scan of the signal at a time, instead of seeing continuous scans.

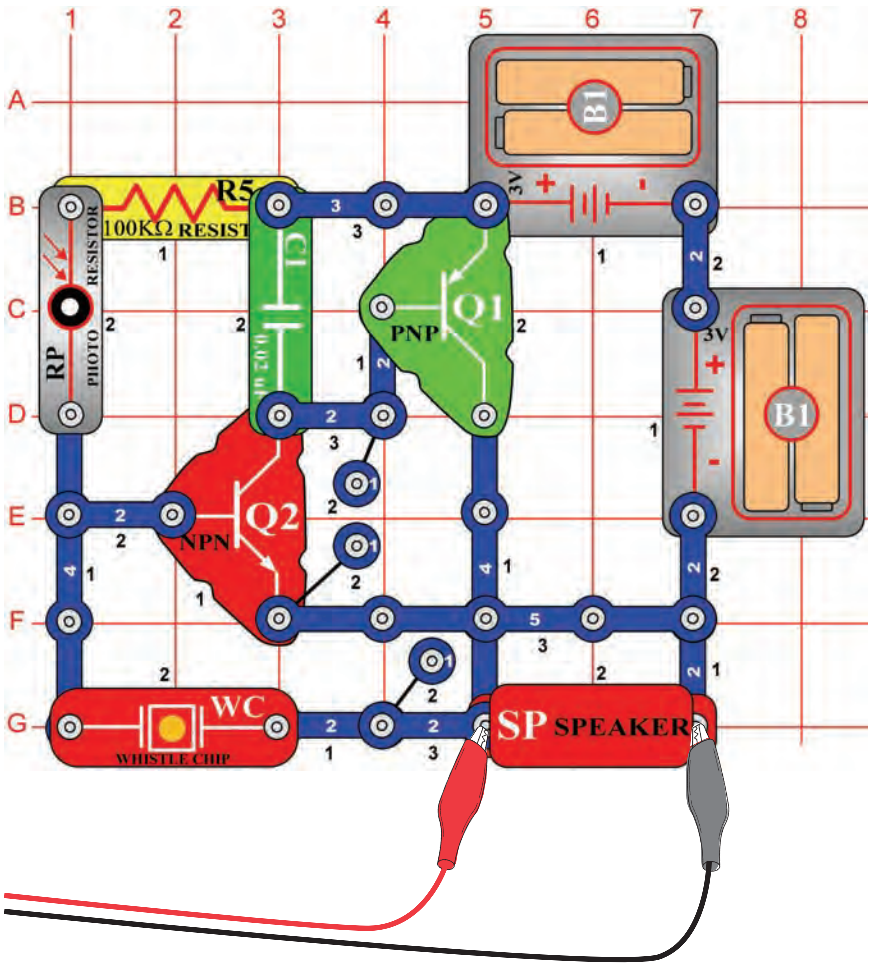
Turn on FFT mode to look at the frequency spectrum, try the **settings** shown here. You can see the spectrums for the different patterns produced by the space war IC, a sample is shown here.



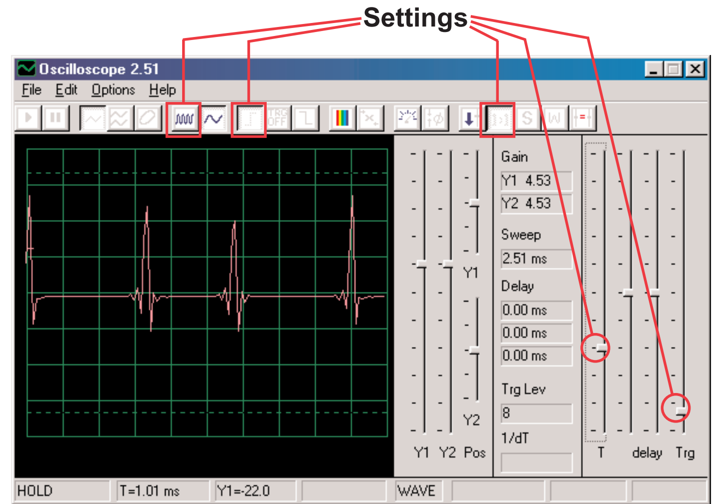
☐ Project #PC21

Buzzing in the Dark PC

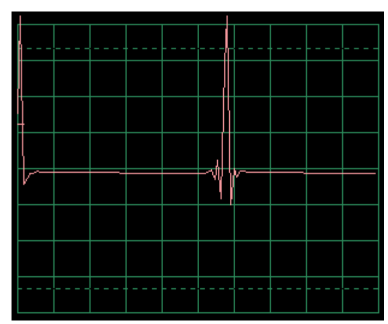
***OBJECTIVE:** To build a circuit that buzzes.*



Build the circuit shown. If continuing from the previous experiment then close the Winscope program and run it again, to reset the settings. Set Winscope to the **settings** shown below and click on the On-Line button to activate. A sample waveform is shown here.

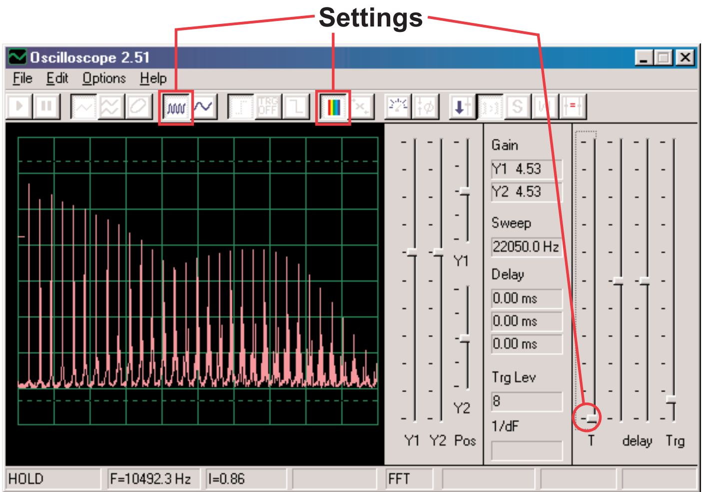


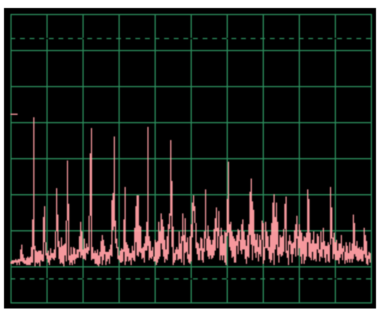
The actual waveform will vary depending on how much light is shining on the photoresistor (snap part RP). If you cover the photoresistor then the circuit shuts off.



The waveform above is weak and erratic, so replace the 0.02μF capacitor (snap part C1) with the 0.1μF capacitor. A sample of the new waveform is at left, with the same settings. It is lower in frequency but higher in amplitude.

Turn on FFT mode to look at the frequency spectrum, try the **settings** shown here.



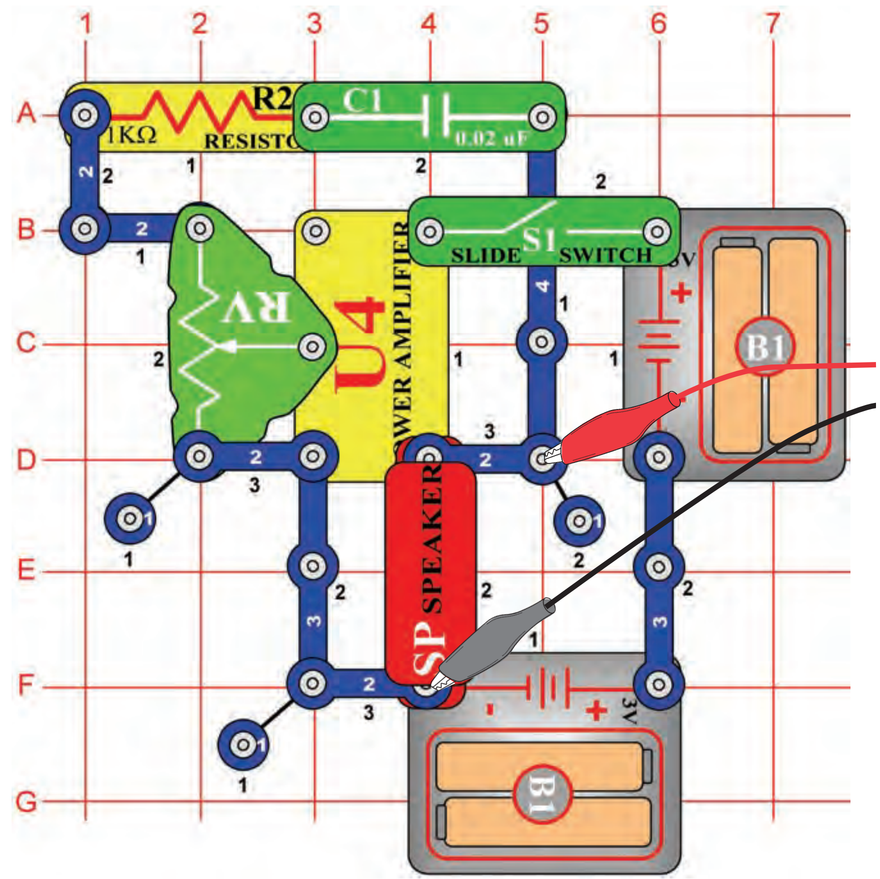


Now put the 0.02µF capacitor back in place of the 0.1µF capacitor to compare its spectrum. A sample is on the left, with the same Winscope settings as above. As with the oscilloscope mode, its spectrum is weaker and more erratic.

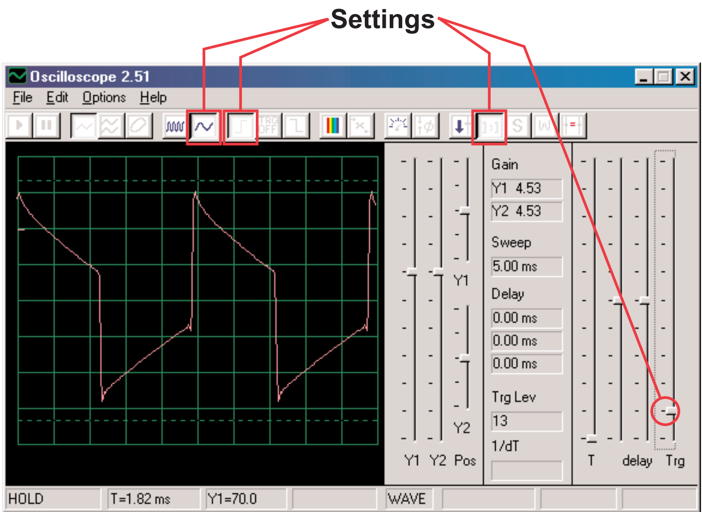
☐ Project #PC22

Trombone PC

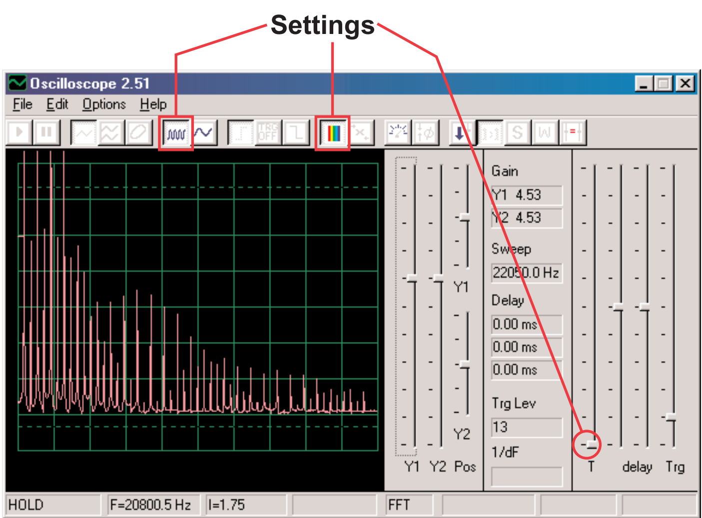
OBJECTIVE: To build a circuit that sounds like a trombone.



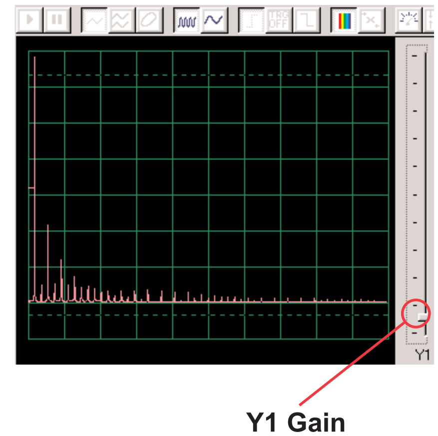
Build the circuit shown. If continuing from the previous experiment then close the Winscope program and run it again, to reset the settings. Click on the On-Line button to activate, and turn on the switch (snap part S1). Set Winscope to the **settings** shown below, and move the lever on the adjustable resistor (snap part RV) around to change the waveform and the sound. At some positions there may be no sound. A sample waveform is shown here.



Turn on FFT mode to look at the frequency spectrum, try the **settings** shown here.

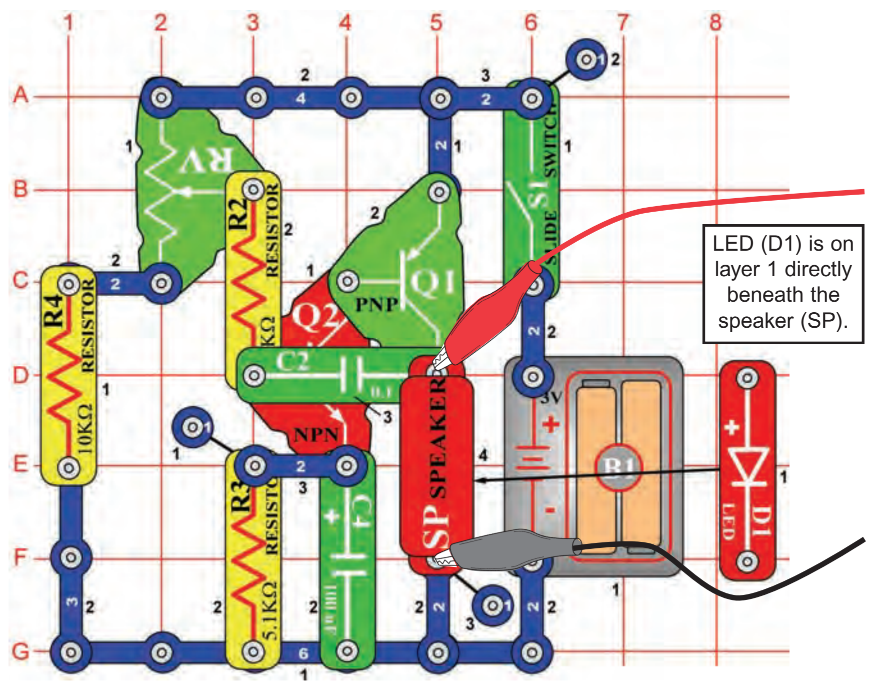


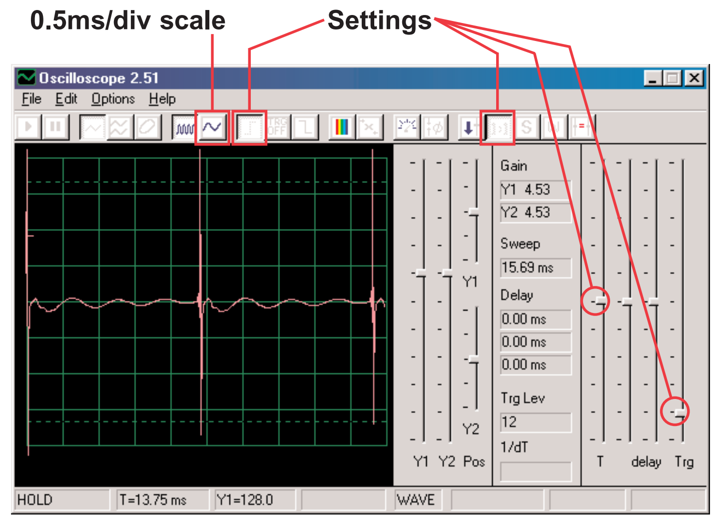
Note that in the above display the Y1 Gain is set high to show the low energy levels of the higher frequency components of the signal, even though the stronger peaks of the lower frequency components are off the top of the display. This can be deceiving. Now change the **Y1 Gain** so that the highest peak can be seen, this is shown on the right. Now you see how the main signal frequency dominates the others.



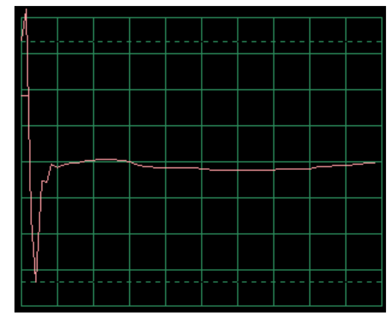
☐
Project #PC23
Sound Pulse Oscillator PC

OBJECTIVE: To build a pulse oscillator.

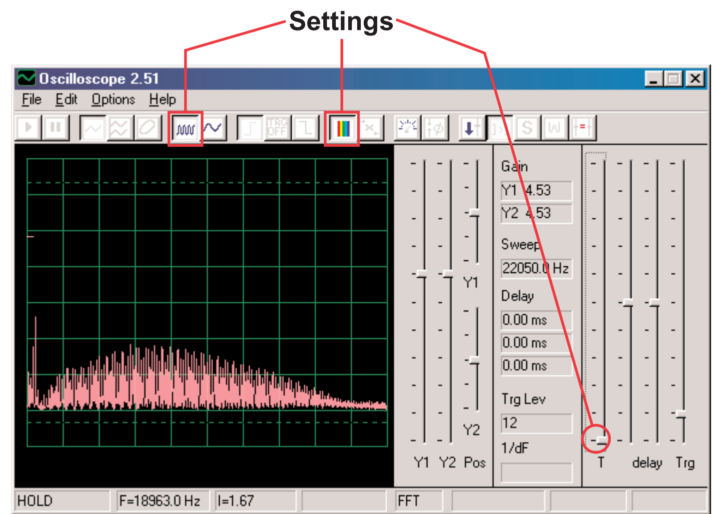




You can also change to the **0.5ms/div scale** to take a closer look at one of the pulses, shown on the right:



Turn on FFT mode to look at the frequency spectrum, try the **settings** shown here.

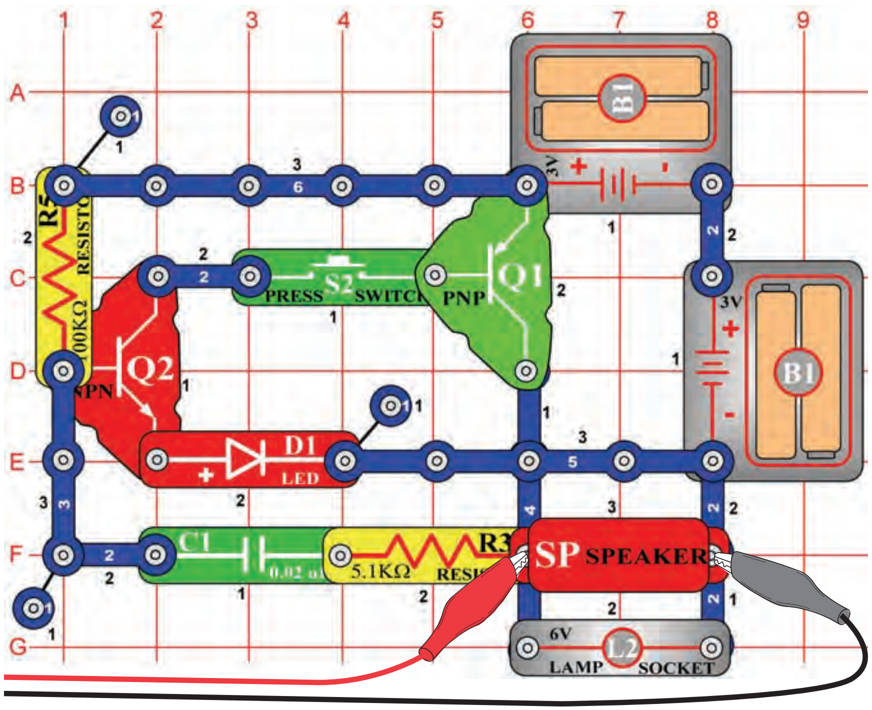


Build the circuit shown. If continuing from the previous experiment then close the Winscope program and run it again, to reset the settings. Click on the On-Line button to activate, and turn on the slide switch (snap part S1). Set Winscope to the **settings** shown on the upper right, and move the lever on the adjustable resistor (snap part RV) around to change the waveform and the sound. At some positions there may be no sound. A sample waveform is shown on the upper right.

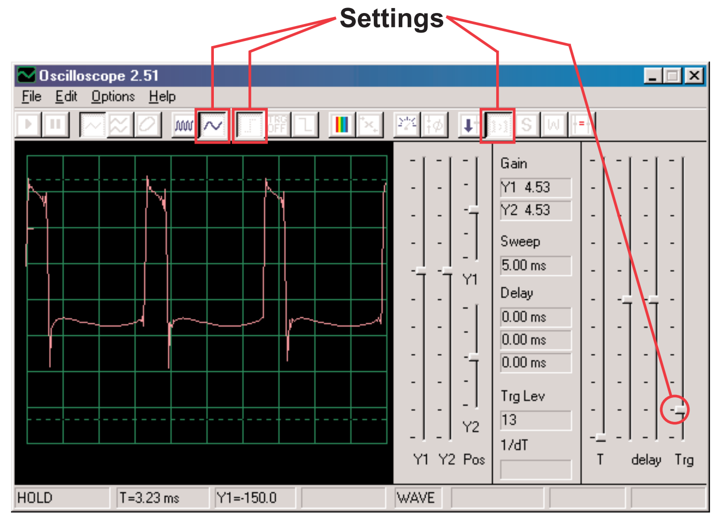
Project #PC24

High Pitch Bell PC

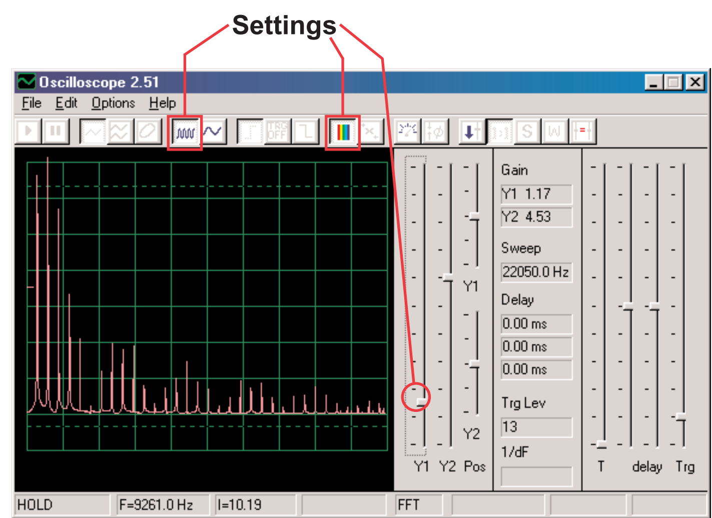
OBJECTIVE: To build a high pitch bell.



Build the circuit shown. If continuing from the previous experiment then close the Winscope program and run it again, to reset the settings. Click on the On-Line button to activate, and hold down the press switch (snap part S2). Set Winscope to the **settings** shown on the upper right. A sample waveform is shown on the upper right.



Turn on FFT mode to look at the frequency spectrum, try the **settings** shown here.

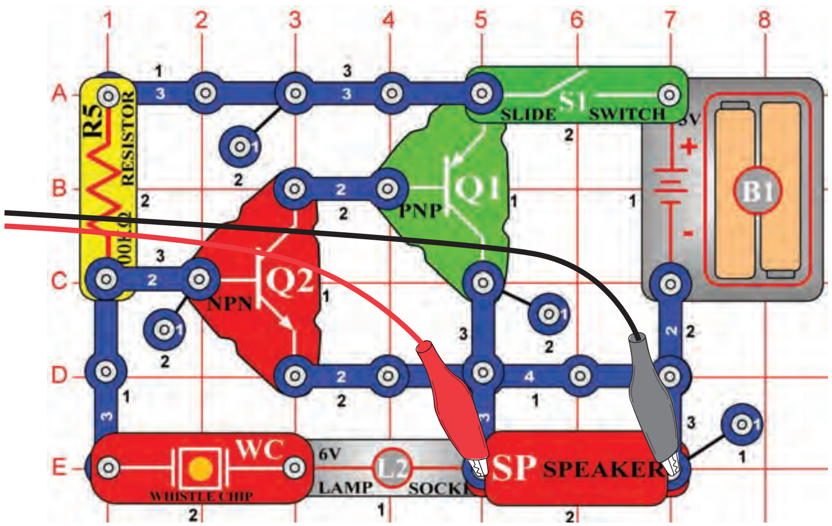


You can change some of the Winscope settings around to view the waveform and spectrum in different ways if desired. You can also place the 0.02μF capacitor on top of the whistle chip to lower the frequency.

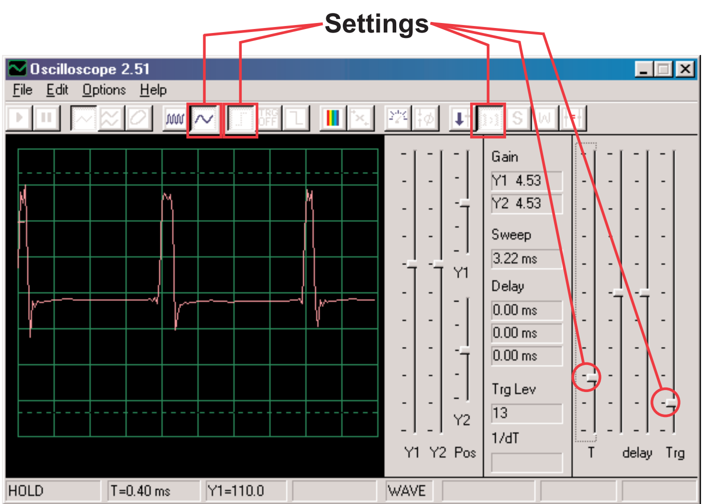
Project #PC25

Tone Generator PC

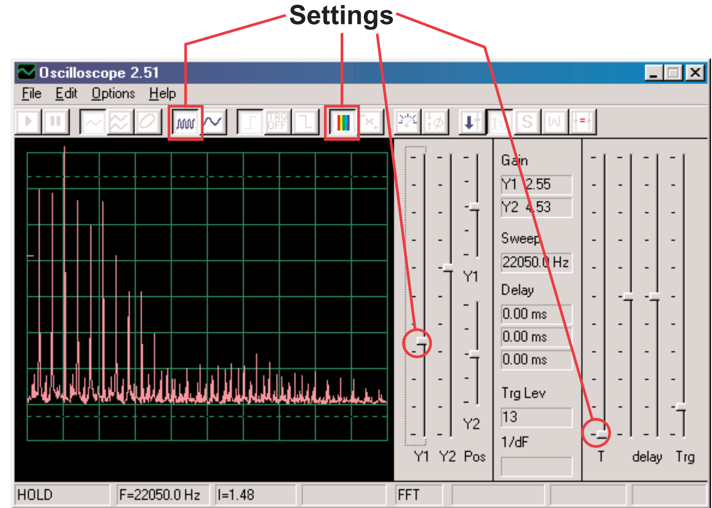
OBJECTIVE: To build a high frequency oscillator.



Build the circuit shown. If continuing from the previous experiment then close the Winscope program and run it again, to reset the settings. Click on the On-Line button to activate, and turn on the switch. Set Winscope to the **settings** shown below. A sample waveform is shown here.



Turn on FFT mode to look at the frequency spectrum, try the **settings** shown here.



Project #PC26

Tone Generator PC (II)

Modify the circuit for project PC25 by placing the 0.02μF capacitor (C1) on top of the whistle chip (WC). Look at the waveform and frequency spectrum using the same settings as for project PC19, the frequency is lower now.

Project #PC27

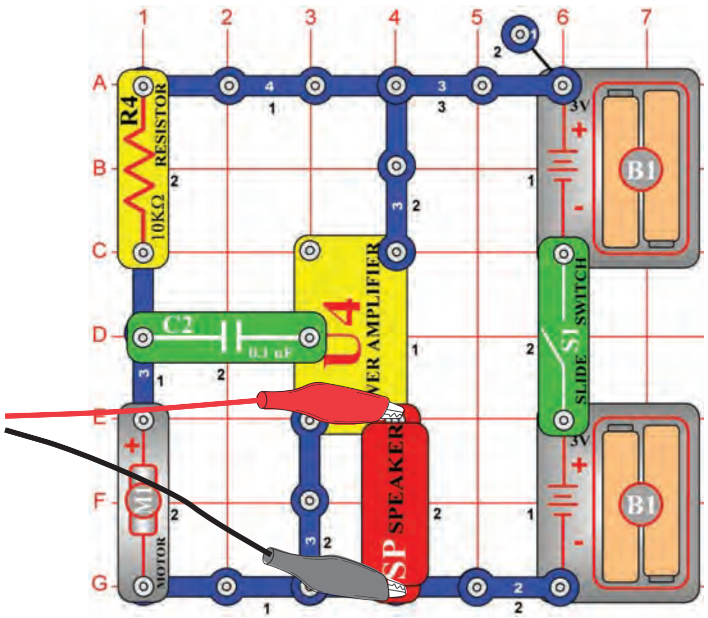
Tone Generator PC (III)

Modify the circuit for project PC25 by placing the 0.1μF capacitor (C2) on top of the whistle chip (WC). Look at the waveform and frequency spectrum using the same settings as for project PC19, but you may want to change the time scale since the frequency is much lower now.

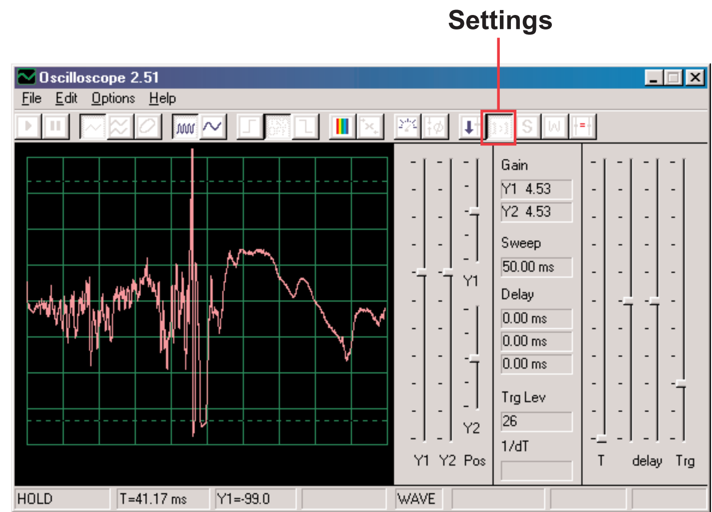
☐ Project #PC28

Old-Style Typewriter PC

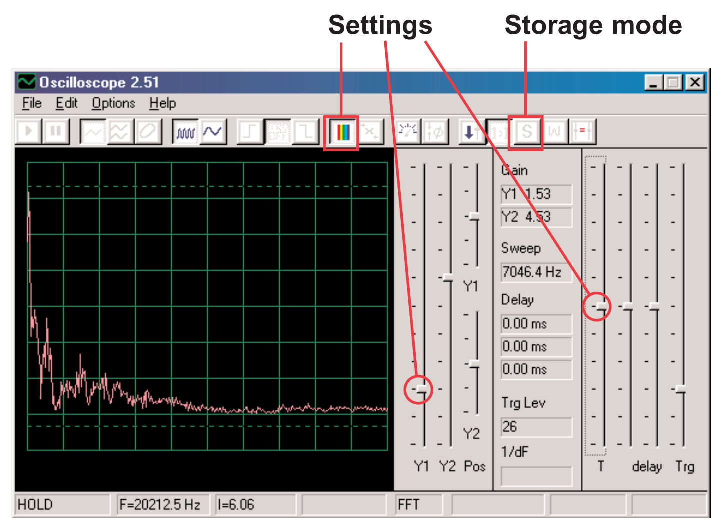
OBJECTIVE: To build a circuit that sounds like a typewriter.



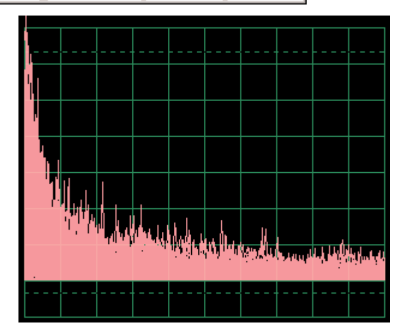
Build the circuit shown. If continuing from the previous experiment then close the Winscope program and run it again, to reset the settings. Click on the On-Line button to activate, and turn on the switch. Set Winscope to the **settings** shown on the upper right. Turn the motor (snap part M1) slowly with your fingers and watch the waveforms generated. They are very erratic and unpredictable. A sample is shown on the upper right.



Turn on FFT mode to look at the frequency spectrum, try the **settings** shown here.



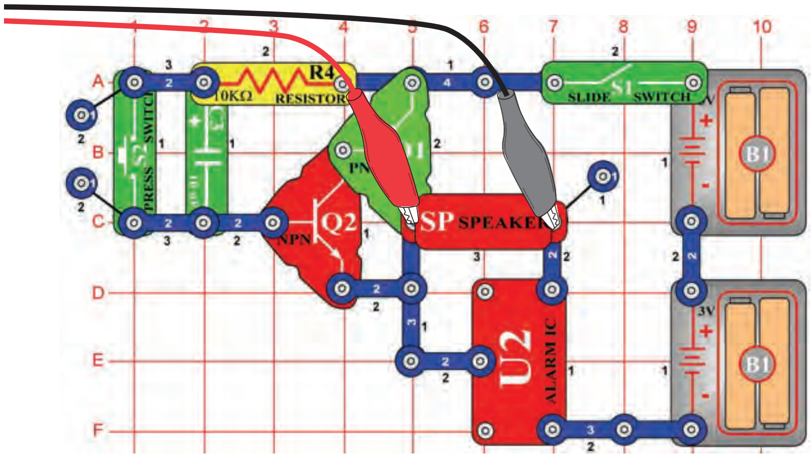
You can also turn on **Storage mode** to see the peaks recorded as you turn the motor, a sample of this is at right.



☐ Project #PC29

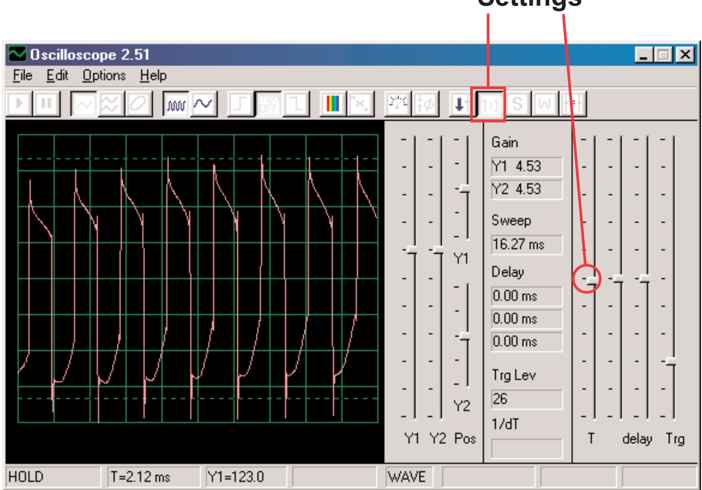
Transistor Fading Siren PC

OBJECTIVE: To build a siren that slowly fades away.



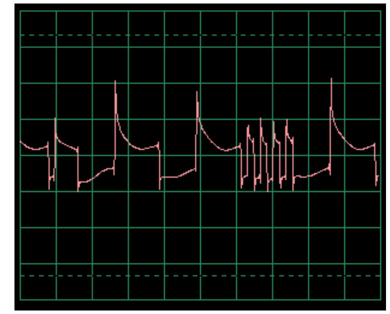
Build the circuit shown. If continuing from the previous experiment then close the Winscope program and run it again, to reset the settings. Set Winscope to the **settings** shown on the right. Click on the On-Line button to activate, turn on the switch, and press the press switch (snap part S2). You hear a siren that slowly fades away.

Settings



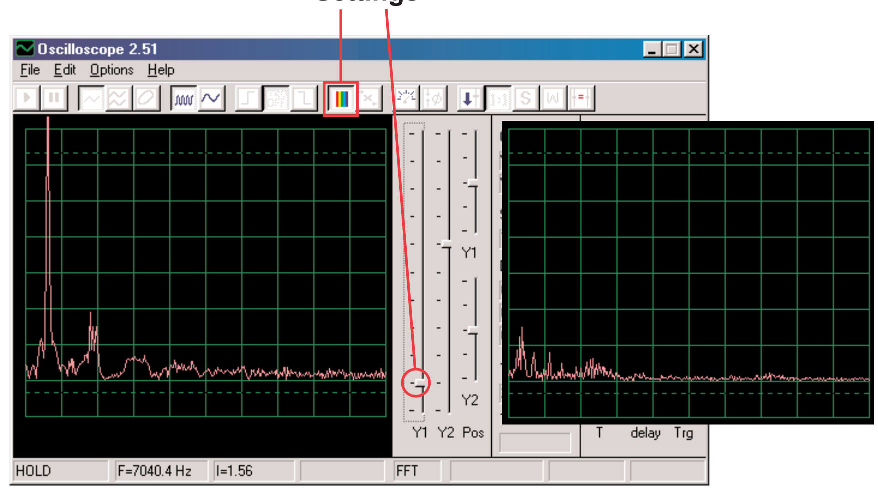
This display shows the siren just after pressing the press switch.

This display (at the same settings) shows the siren when it has almost faded out. The waveform has become weak and sometimes erratic.



Turn on FFT mode to look at the frequency spectrum, try the **settings** shown here. The display on the left shows the signal just after pressing the press switch and on the right shows it just before it fades out.

Settings



☐ Project #PC30

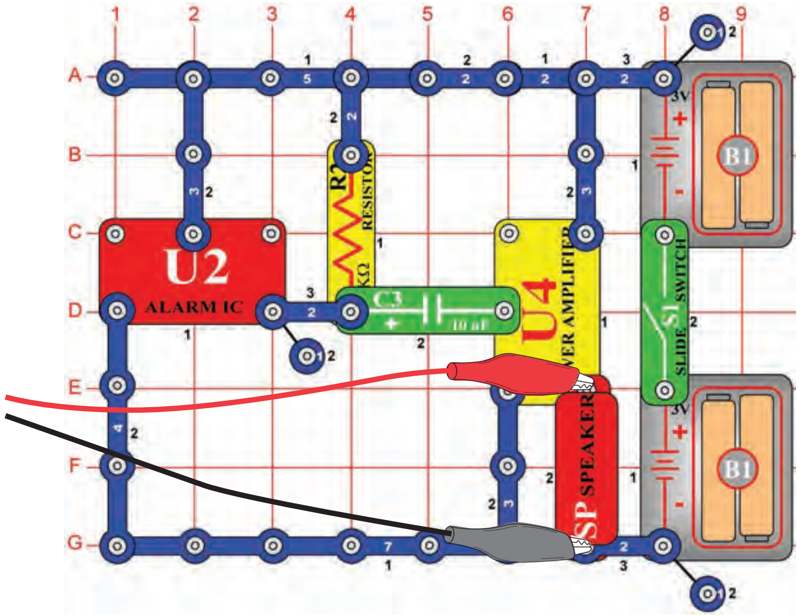
Fading Doorbell PC

Modify the circuit in PC29 by replacing the alarm IC (U2) with the music IC (U1), use a 1-snap and a 2-snap to make a connection across D6-E6 on top of the music IC. The music slowly fades away and stops. Use the same settings as in PC29 to view the waveform and frequency spectrum.

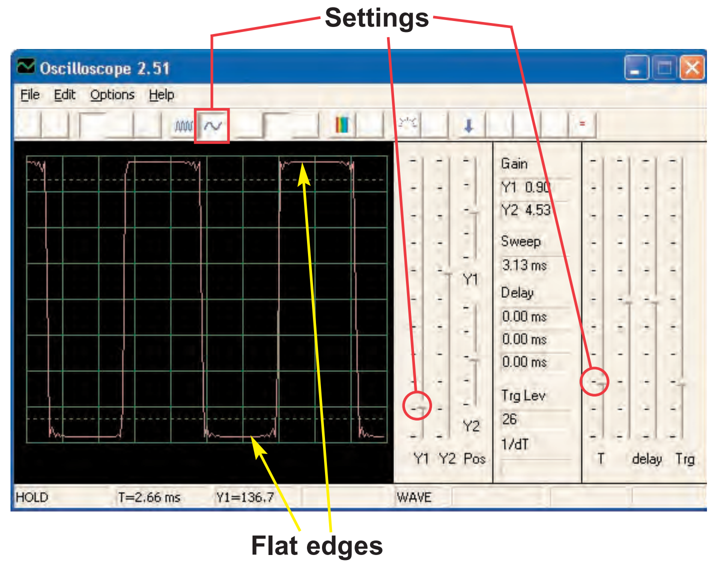
Project #PC31

Police Siren Amplifier PC

OBJECTIVE: To show the output of an amplifier.



Build the circuit shown and set Winscope to the **settings** shown below. The siren sound is very loud. In most cases the waveform will have **flat edges** on the top and bottom, indicating the voltage is too high for the microphone input stage on your computer and is being distorted. You may sometimes correct for this if you like by reducing the volume control of your microphone input (see p. 3), but it is recommended that you return the volume to the normal level before doing other projects.



You may also make different alarm sounds by connecting the alarm IC using the configurations shown in projects #23-26.

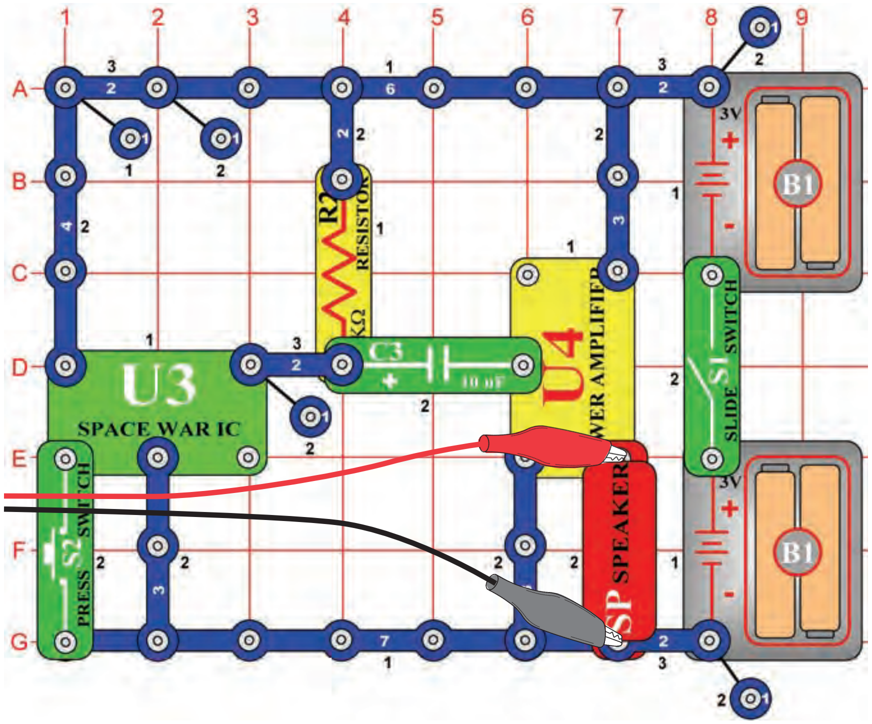
Project #PC32

Music Amplifier PC

Modify the circuit in PC31 by replacing the alarm IC (U2) with the music IC (U1). Use the same settings as in PC31 to view the waveform, you may also use the FFT button to view the frequency spectrum.

Project #PC33

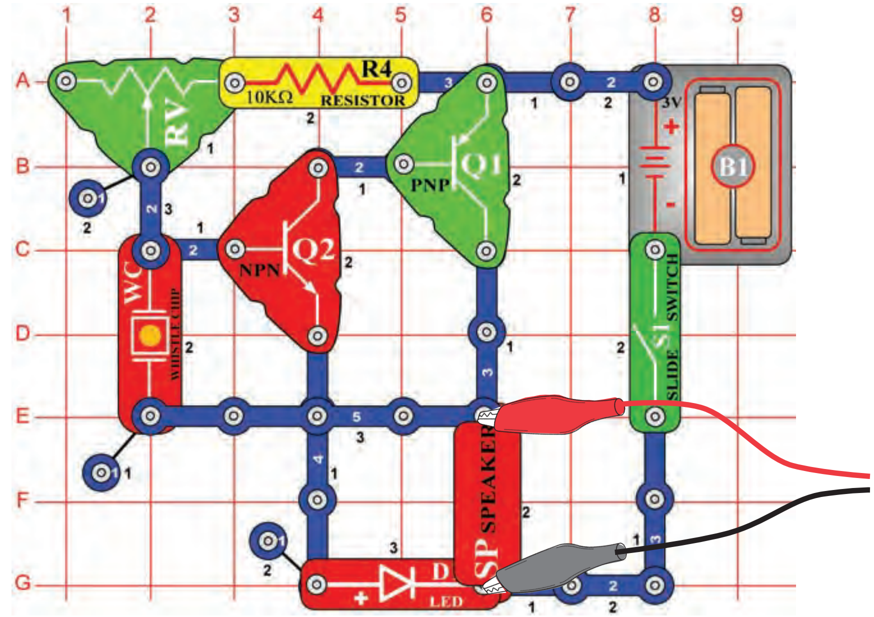
Space War Amplifier PC



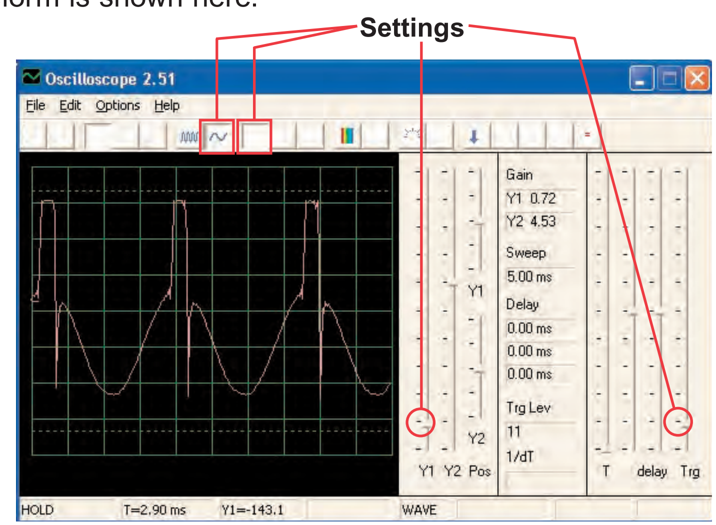
Build the circuit shown and use the same settings as in PC31 to view the waveform. Press the switch (S2) to change the sounds and waveform.

Project #PC34

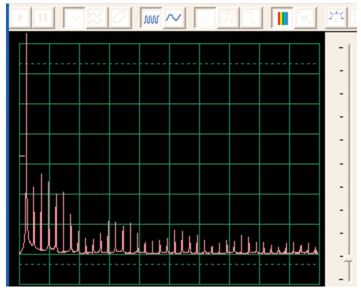
Adjustable Tone Generator PC



Build the circuit shown, and try the **settings** below. Move the adjustable resistor lever to change the frequency. A sample waveform is shown here.



Try these settings to see the spectrum:



☐ Project #PC35

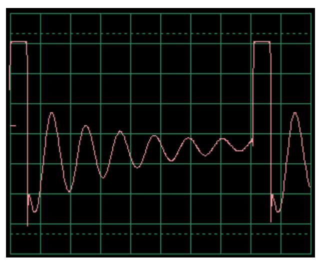
Adjustable Tone Generator PC (II)

Modify the circuit for project PC34 by placing the 0.02μF capacitor (C1) on top of the whistle chip (WC). Look at the waveform and frequency spectrum using the same settings as for project PC34, the frequency is lower now.

☐ Project #PC36

Adjustable Tone Generator PC (III)

Modify the circuit for project PC34 by placing the 0.1μF capacitor (C2) on top of the whistle chip (WC). Look at the waveform and frequency spectrum using the same settings as for project PC34, but you may want to change the time scale since the frequency is much lower now.



☐ Project #PC37

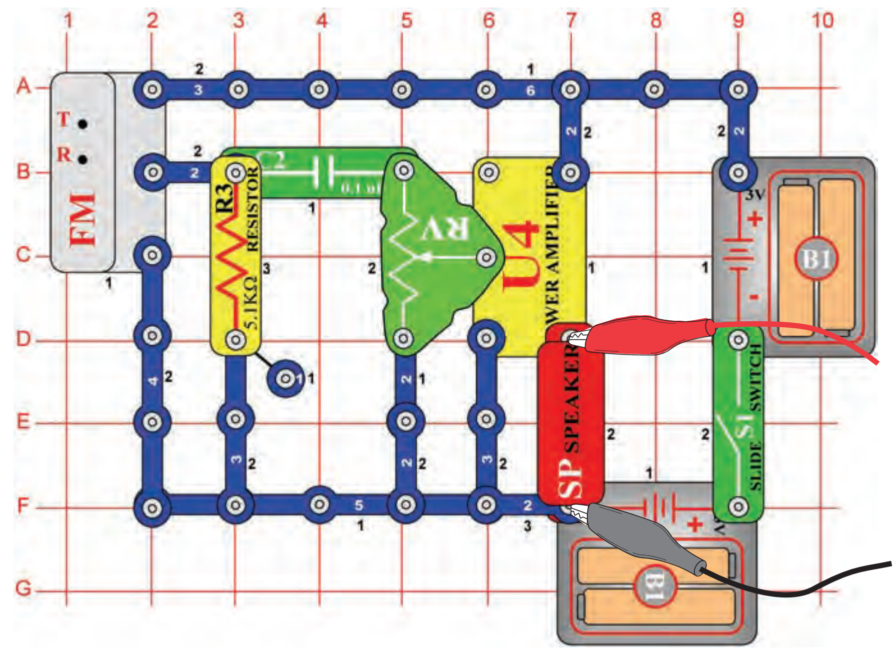
Adjustable Tone Generator PC (IV)

Modify the circuit for project PC34 by replacing the 10KΩ (R4) resistor with the photoresistor (RP). Look at the waveform and frequency spectrum using the same settings as for project PC34, and wave your hand over the photoresistor to change the sound and pattern. There will not always be sound.

☐ Project #PC38

Adjustable FM Radio PC

OBJECTIVE: To show the output of an FM Radio.



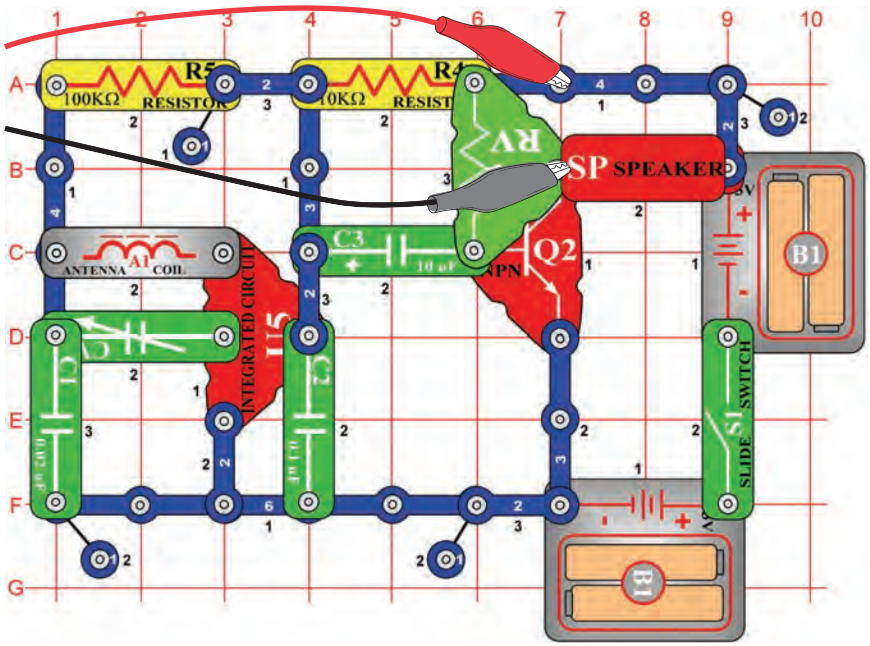
Turn on the slide switch (S1) and press the R button. Now press the T button and the FM module scans for a radio station. When a station is found, it locks on to it and you hear it on the speaker. Press the T button again for the next radio station.

Connect the PC-interface cable as shown. Set up Winscope as desired or use the same Winscope settings to view the waveform and frequency spectrum as for project PC12 (AM radio), since the output signal to the speaker is music or talking just like in PC12. (AM and FM radio transmit the same types of information using different modulation methods.) Adjust the volume using the adjustable resistor (RV) so that all of the waveform is shown on the Winscope screen.

☐ Project #PC39

Transistor AM Radio PC (II)

OBJECTIVE: To show the output of an AM Radio.

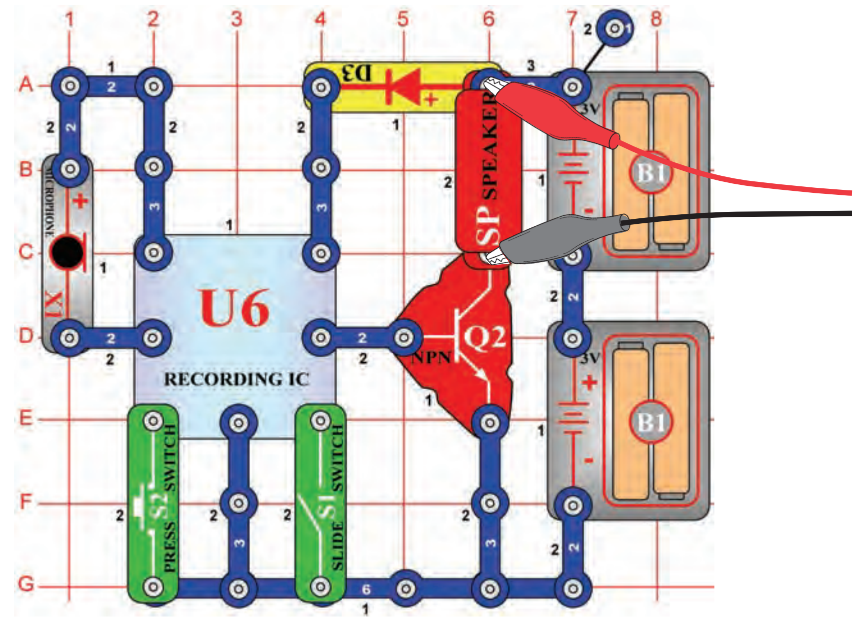


Turn on the switch and adjust the variable capacitor (CV) for a radio station, then adjust the loudness using the adjustable resistor (RV). Use the same Winscope settings as for project PC12 (AM radio) to view the waveform and frequency spectrum. The waveform will be different from that in projects PC12 and PC38, because those circuits use the power amplifier IC (U4) instead of the NPN transistor for amplification.

☐ Project #PC40

Playback & Record PC

OBJECTIVE: To show the waveforms for music and your voice.

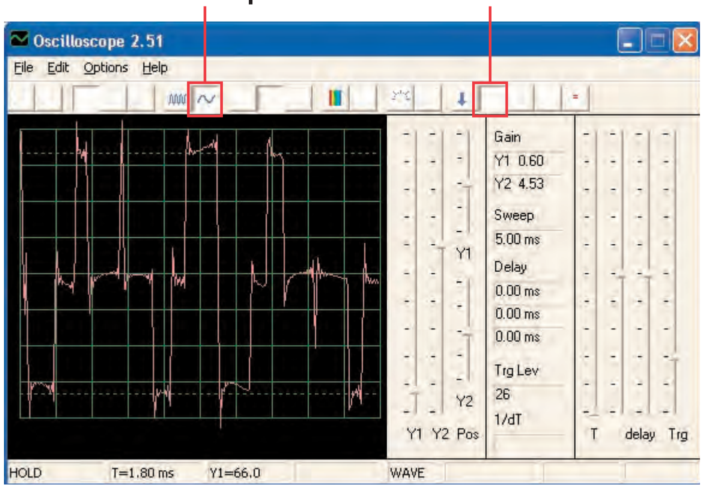


Build the circuit shown. Turn on the slide switch (S1), you hear a beep signaling that you may begin recording. Talk into the microphone (X1) up to 8 seconds, and then turn off the slide switch (it also beeps after the 8 seconds expires).

Press the press switch (S2) for playback. It plays the recording you made followed by one of three songs. If you press the press switch before the song is over, the music will stop. You may press the press switch several times to play all three songs.

Use Winscope to view the waveform and frequency spectrum when playing back your recording and music. A **sample music waveform** is shown here.

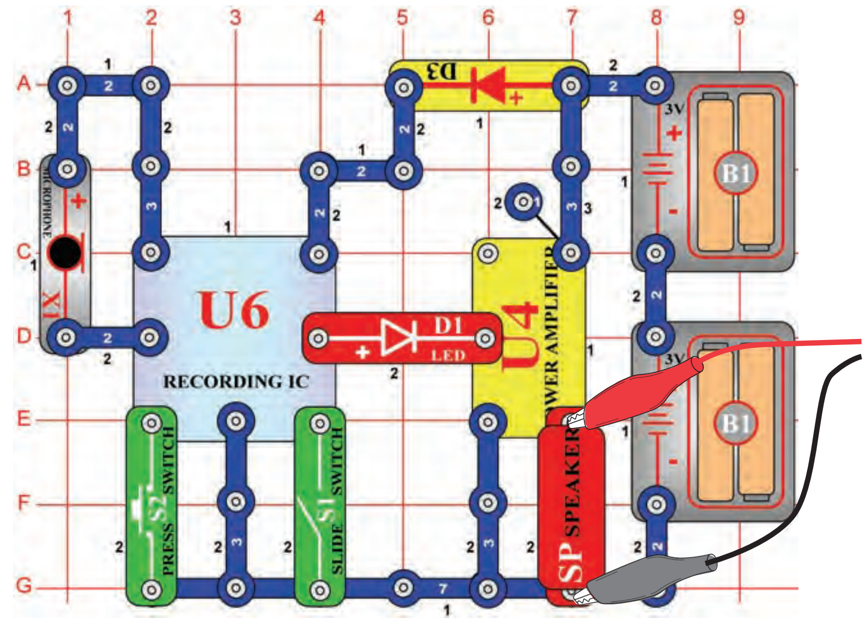
Sample music waveform



Project #PC41

Power Amplifier Playing Music IC

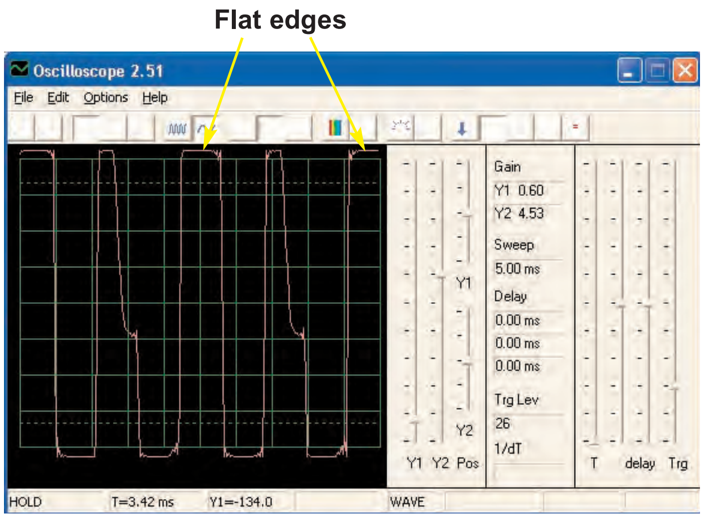
OBJECTIVE: To show how high amplification can distort music.



Build the circuit shown. Turn on the slide switch (S1), you hear a beep signaling that you may begin recording. Talk into the microphone (X1) up to 8 seconds, and then turn off the slide switch (it also beeps after the 8 seconds expires).

Press the switch S2 for playback. It plays the recording you made followed by one of three songs. If you press the press switch (S2) before the song is over, the music will stop. You may press the press switch several times to play all three songs.

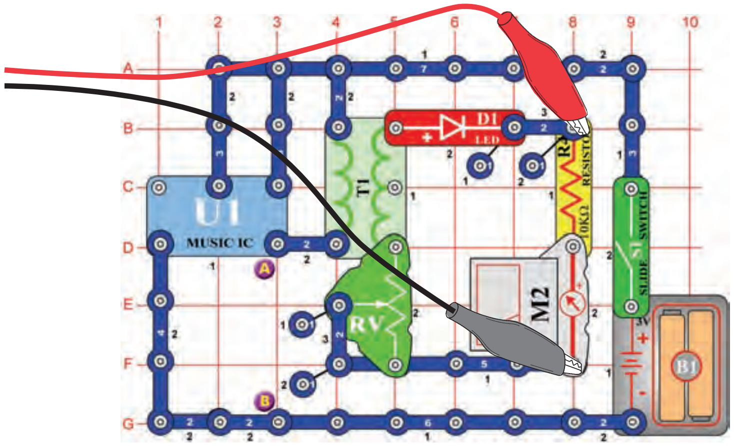
This recorder IC circuit works the same as in project PC40 except that the power amplifer IC (U4) used here makes the sound much louder than in project PC40. If viewed with the same Winscope settings as in PC40, then the waveform appears as shown below. The output from the recorder IC has not changed, but the **flat edges** at the top and bottom of the waveform indicate that the higher amplification is distorting the sound.



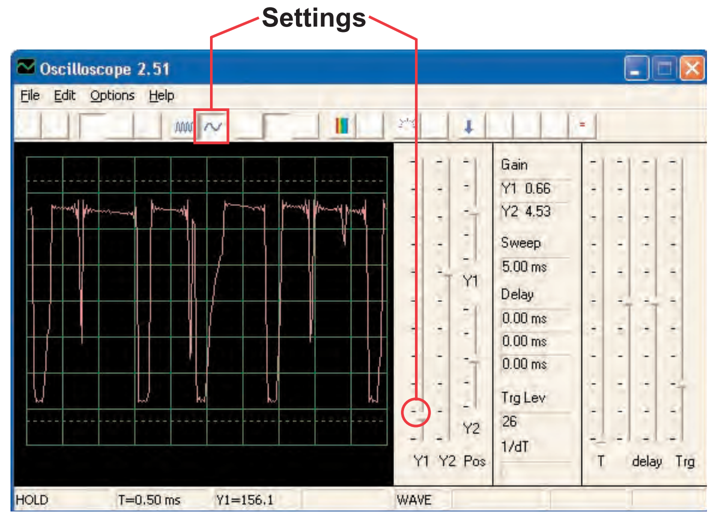
Project #PC42

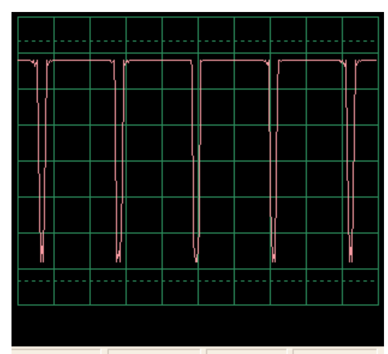
Music Meter PC

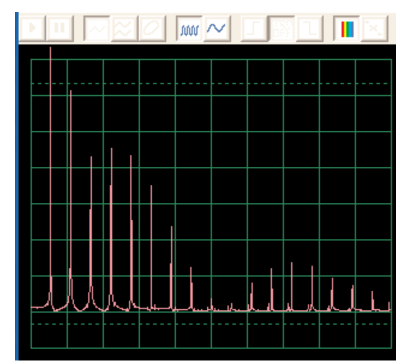
OBJECTIVE: To show how high amplification can distort music.



Use the LOW (or 10mA) setting on the meter (M2). Set the adjustable resistor (RV) to the bottom position and turn on the slide switch (S1), you will see a waveform like that shown below. Set the adjustable resistor to the top, and the waveform looks like that shown on the bottom left, due to lower resistance in the circuit. A sample frequency spectrum is also shown on the bottom right.



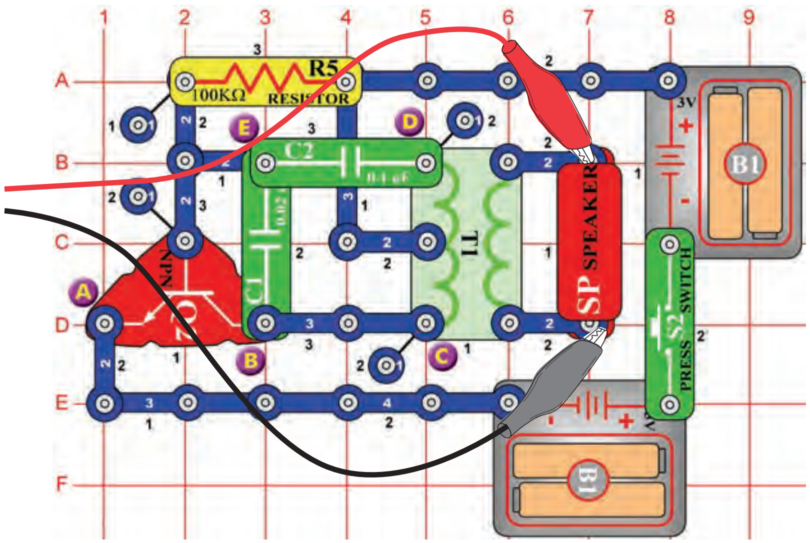




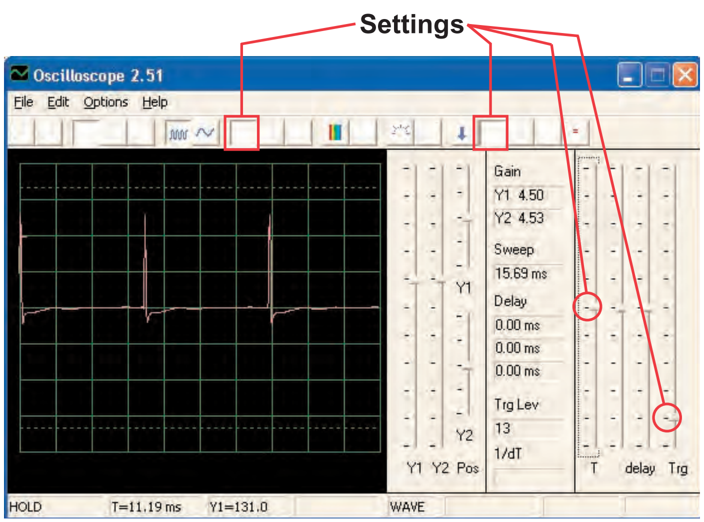
☐ Project #PC43

Oscillation Sounds PC

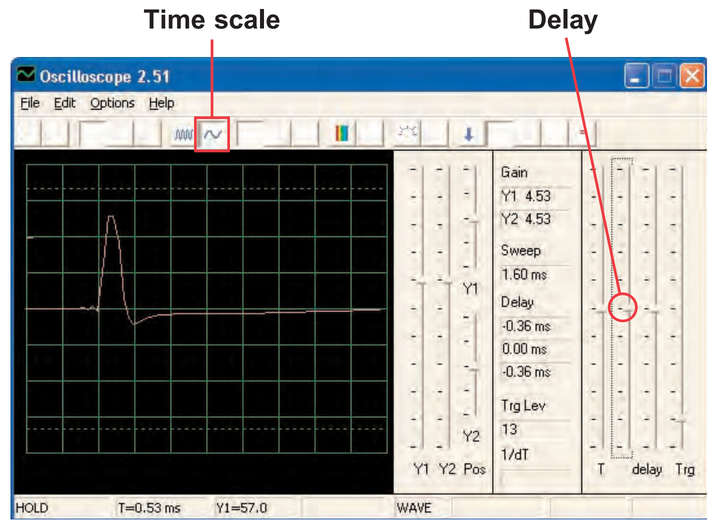
OBJECTIVE: To view the output of an oscillator circuit.



Build the circuit and try the **settings** shown here. This circuit produces a series of pulses (shown below), representing when the transistor is activated.



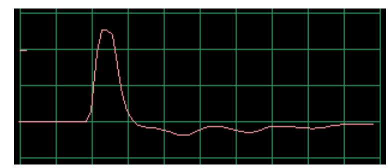
You may look at a pulse close-up by changing the **time scale** and slightly adjusting the **delay**, as shown.



You may look at the frequency spectrum on your own if desired.

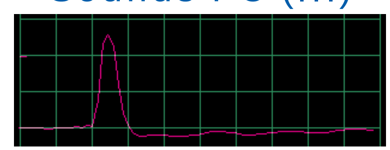
☐ Project #PC44 Oscillation Sounds PC (II)

Using the circuit from PC43, connect the whistle chip across points C & D. Notice how the shape of the pulse has changed from that shown in PC43 (using the same settings):



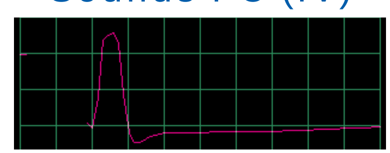
☐ Project #PC45 Oscillation Sounds PC (III)

Using the circuit from PC43, connect the whistle chip across points B & E. Notice how the shape of the pulse has changed.



☐ Project #PC46 Oscillation Sounds PC (IV)

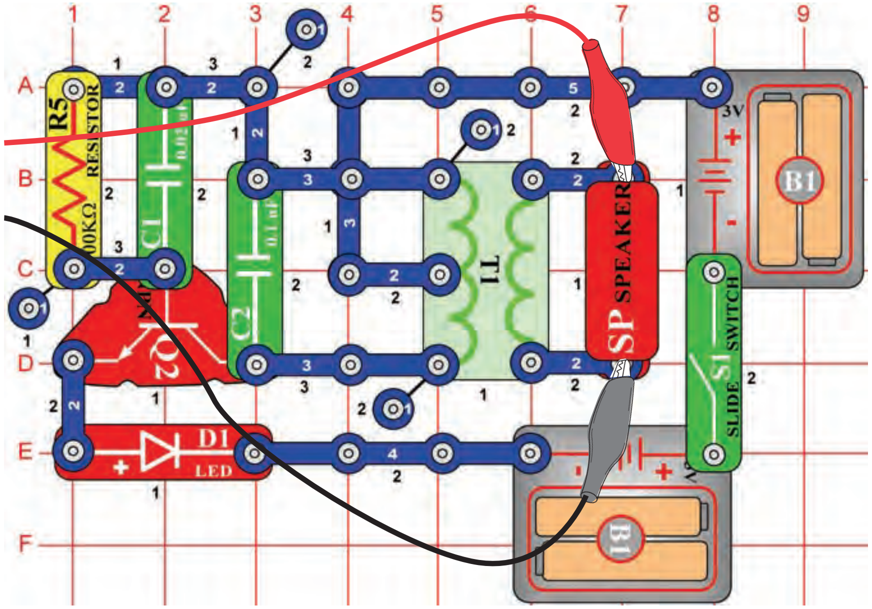
Using the circuit from PC43, install the whistle chip under capacitor C2. Notice how the shape of the pulse has changed.



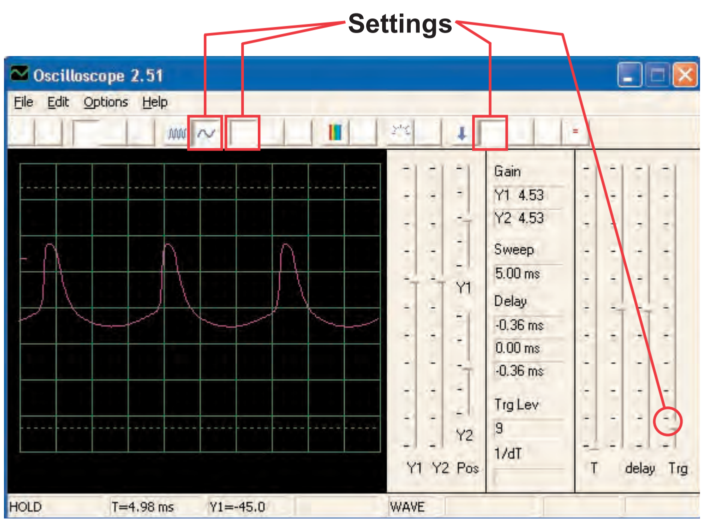
Project #PC47

Oscillator Sounds PC

OBJECTIVE: To view the output of an oscillator circuit.



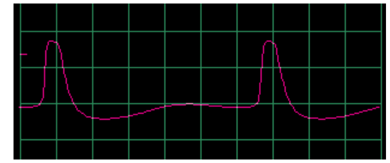
Build the circuit and try the **settings** shown.



Project #PC48

Oscillation Sounds PC (II)

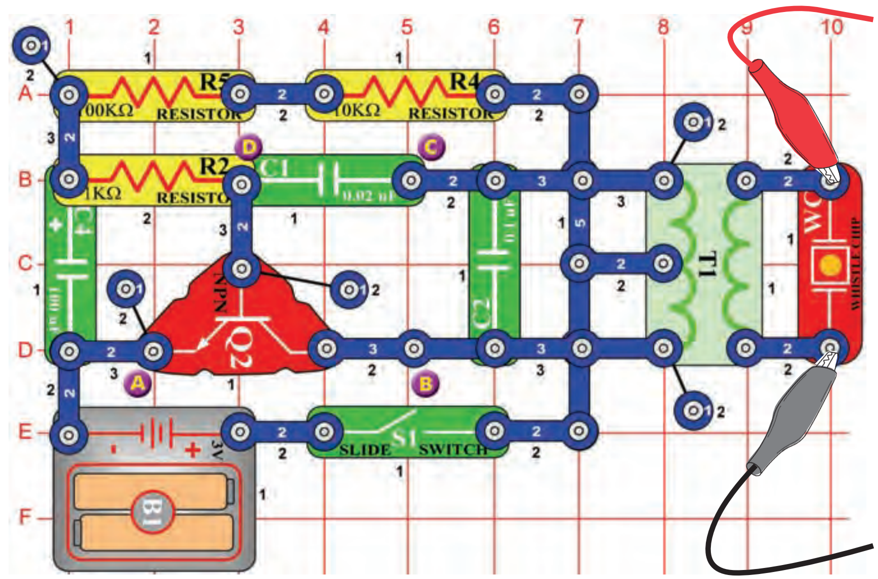
Using the circuit from PC47, install the whistle chip on top of capacitor C1. Notice how the spacing between the pulses has changed.



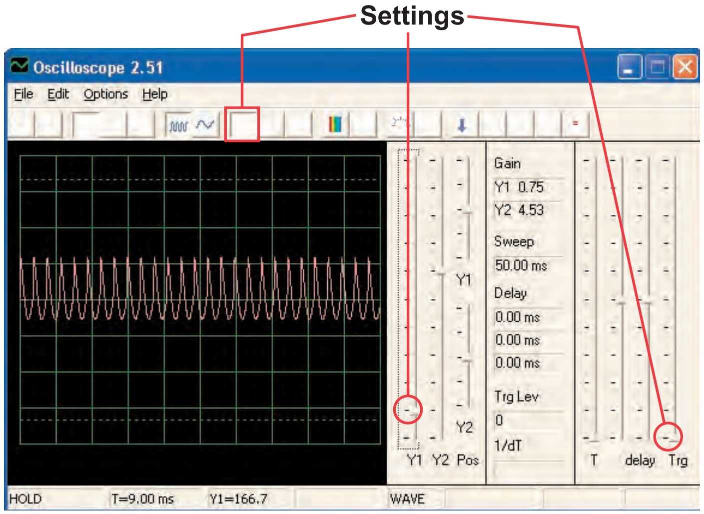
Project #PC49

Whistle Chip Sounds PC

OBJECTIVE: To view the output of an oscillator circuit.

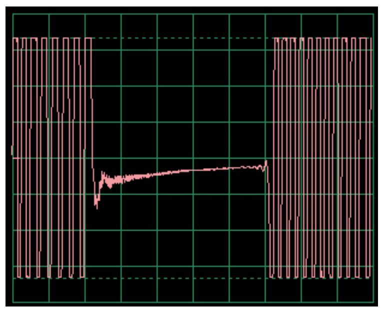


Build the circuit and try the **settings** shown. You may try other settings to zoom in or look at the frequency spectrum.



Project #PC50

Whistle Chip Sounds PC (II)



Connect the whistle chip (with the PC-interface cable still connected across it) across points B & C. The circuit oscillates in short intervals.

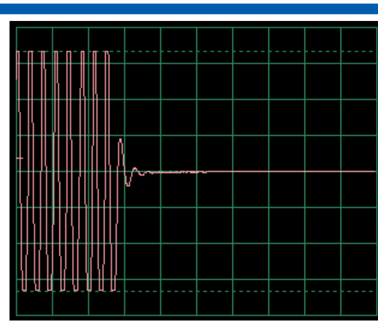
Project #PC51

Whistle Chip Sounds PC (III)

Connect the whistle chip (with PC cable) across points C & D using a 1-snap, the sound and waveforms are different.

Project #PC52

Whistle Chip Sounds PC (IV)

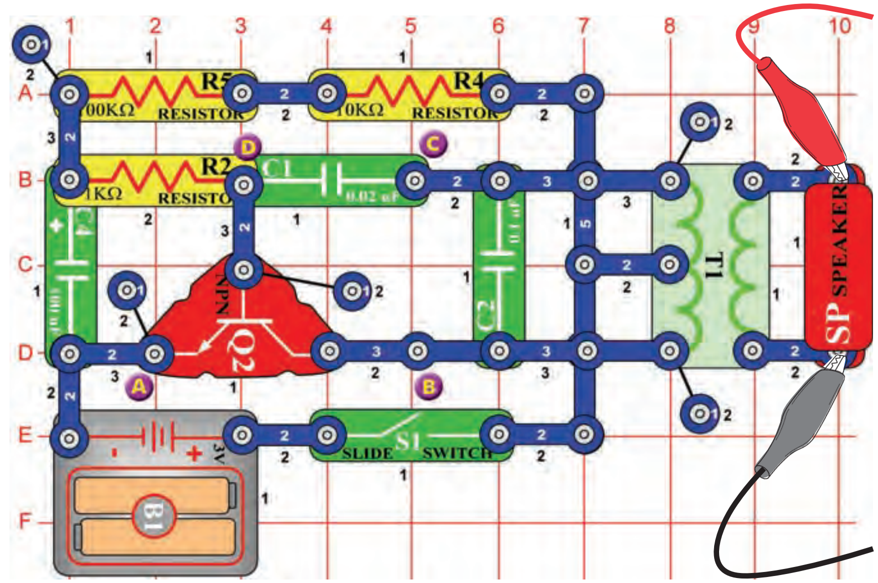


Place the 470μF capacitor C5 on top of the 100μF capacitor C4, and connect the whistle chip across points A & B. The circuit oscillates in 2-second intervals.

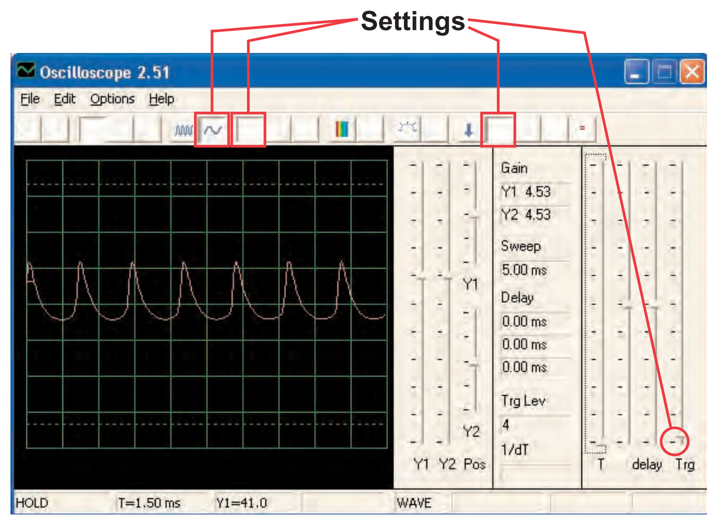
Project #PC53

Bird Sounds PC

OBJECTIVE: To view the output of an oscillator circuit.

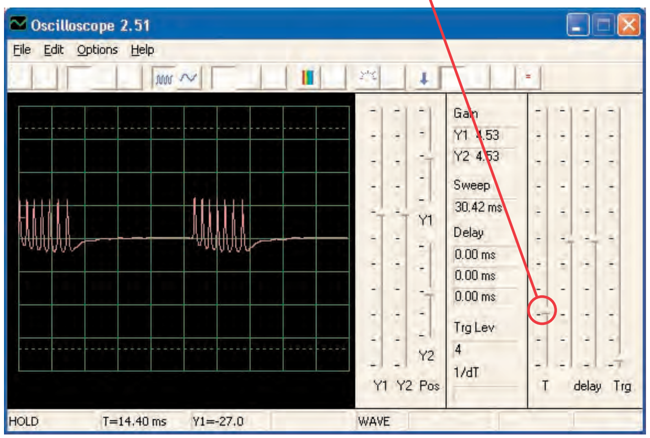


Build the circuit and try the **settings** shown. The oscillator activates about once-a-second, sounding like a bird chirping. You may look at the frequency spectrum if you like.



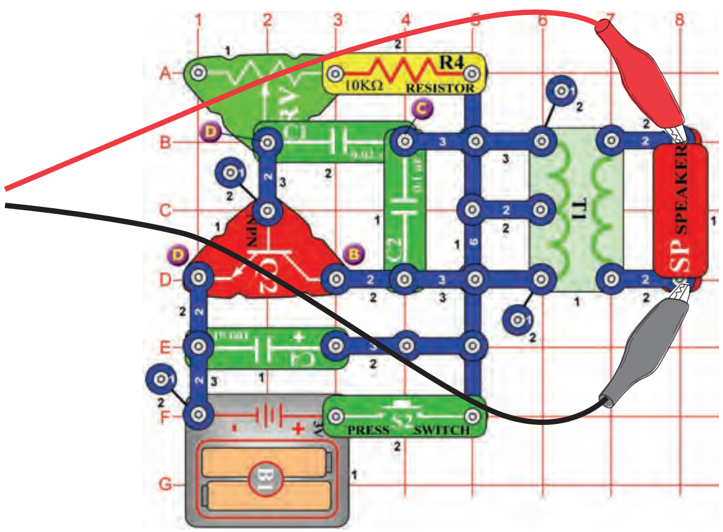
☐ Project #PC54 Bird Sounds PC (II)

Replace the 100µF capacitor (C4) with the 10µF capacitor (C3). The frequency of the oscillator is the same as before (and so the pulses look the same), but the oscillator activates in shorter intervals (so the bursts of pulses are shorter but closer together). You could use the 470µF capacitor to increase the oscillation interval.

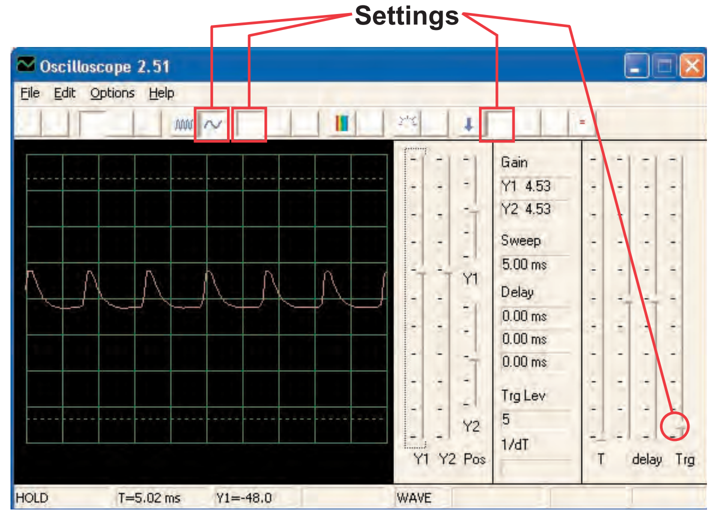


☐ Project #PC55 Electronic Cat PC

OBJECTIVE: To view the output of an oscillator circuit.



Build the circuit and try the **settings** shown. Start with the adjustable resistor set to the left but then adjust to change the tone. The signal dies out after you release the switch.

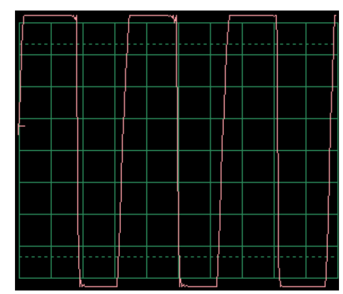


☐ Project #PC56 Electronic Cat PC (II)

Connect the whistle chip across points A & B, then B & C, then C & D and observe how the waveform changes as the sound changes.

☐ Project #PC57 Electronic Cat PC (III)

Remove the speaker. Connect the PC interface cable across the whistle chip and install the whistle chip across points A & B, then B & C, then C & D and observe how the waveform changes as the sound changes. Try different settings of the adjustable resistor. The waveform for B & C is shown.



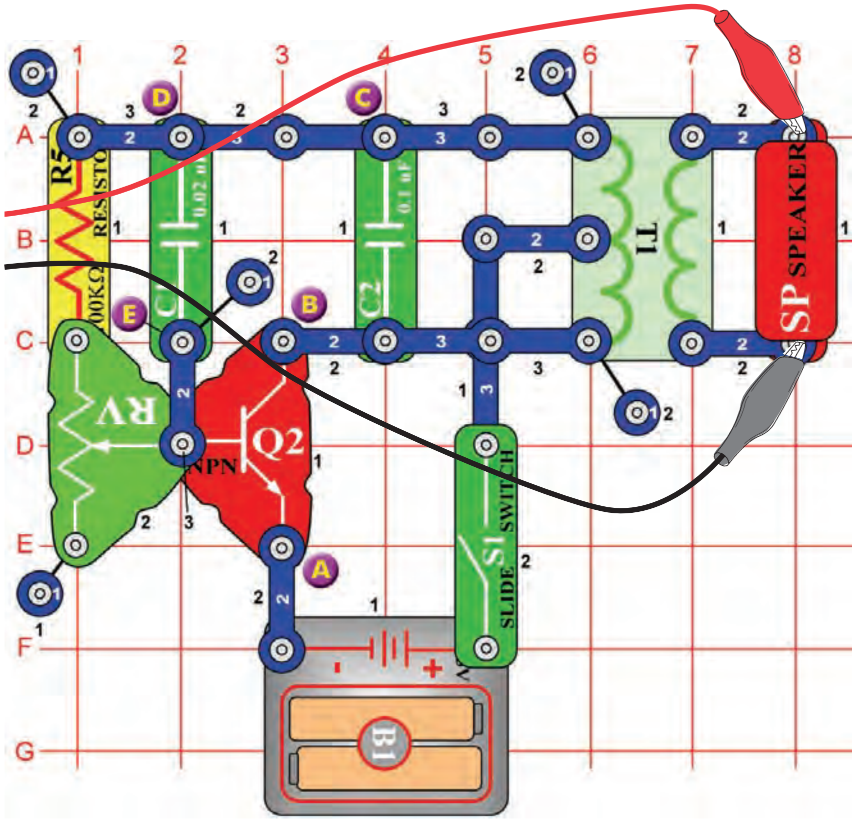
☐ Project #PC58 Electronic Cat PC (IV)

Replace the 100µF capacitor with the 470µF capacitor and repeat projects PC55-PC57. The signal dies out at a much slower rate now, making it easier to observe. You can also use FFT mode to view the frequency spectrum as desired.

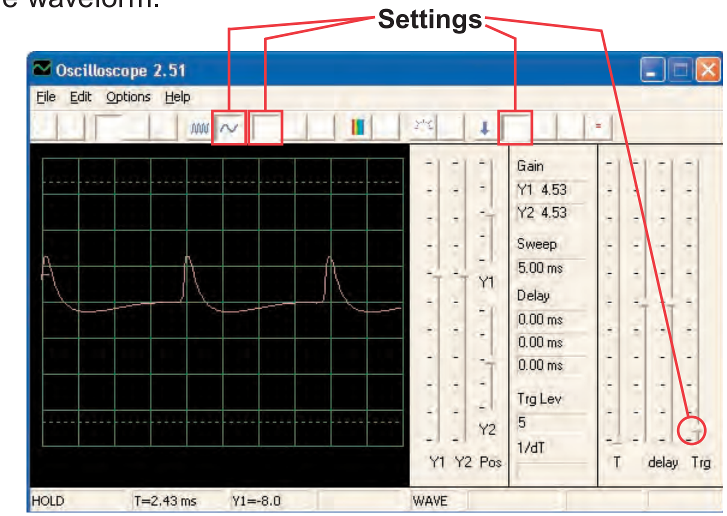
Project #PC59

Variable Oscillator PC

OBJECTIVE: To view the output of an oscillator circuit.



Build the circuit and try the **settings** shown. Move the adjustable resistor lever to change the pitch of the sound and pulse separation in the waveform.



Project #PC60 Variable Oscillator PC (II)

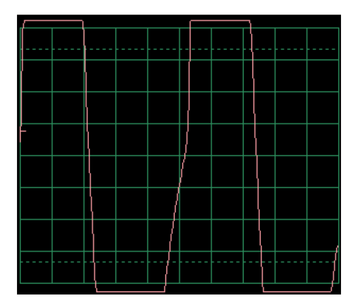
Connect the whistle chip across points A & B, then B & C, then D & E and observe how the waveform changes as the sound changes. Sometimes the speaker sound and waveform are unchanged, but the whistle chip itself makes new sound.

Project #PC61 Variable Oscillator PC (III)

Replace the 100KΩ resistor R5 with the photoresistor RP, wave your hand or a piece of paper over it and observe how the sound and waveform change.

Project #PC62 Variable Oscillator PC (IV)

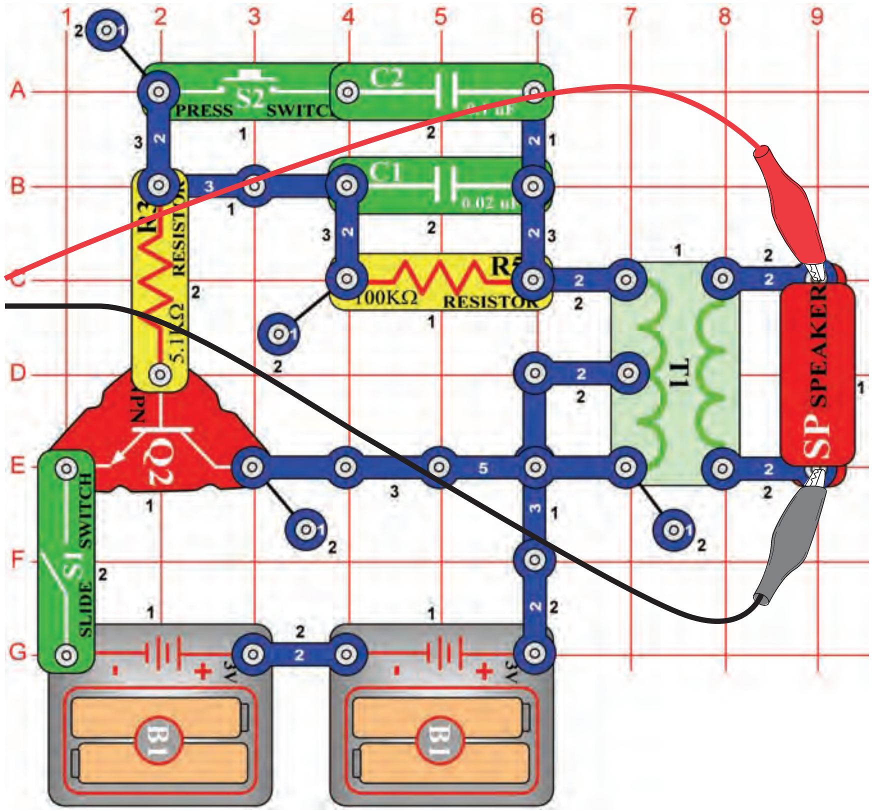
Remove the speaker. Connect the PC interface cable across the whistle chip and install the whistle chip across points A & B, then B & C, then D & E and observe how the waveform changes as the sound changes. Try different settings of the adjustable resistor. The waveform for A & B is shown.



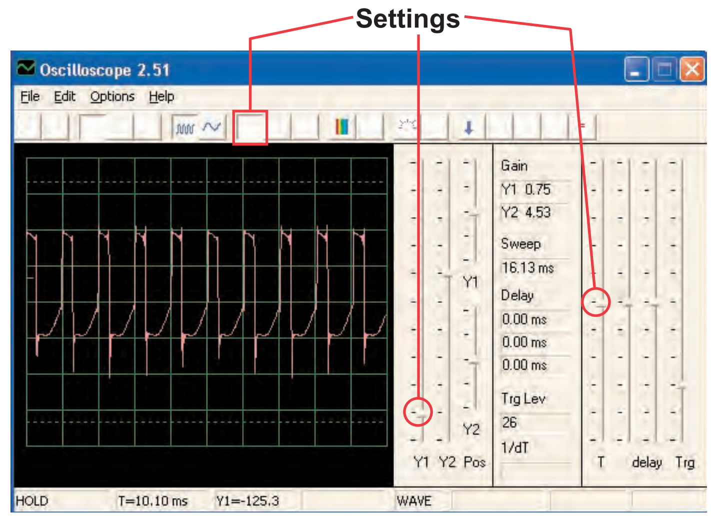
Project #PC63

Electronic Sound PC

OBJECTIVE: To view the output of an oscillator circuit.



Build the circuit and try the **settings** shown. Press the press switch to lower the frequency of the signal by increasing the capacitance in the oscillator. You can replace the 0.1μF capacitor C2 with the 10μF capacitor C3 ("+" on the right) to further lower the frequency of the tone. You may try other settings to zoom in or look at the frequency spectrum.



Project #PC64

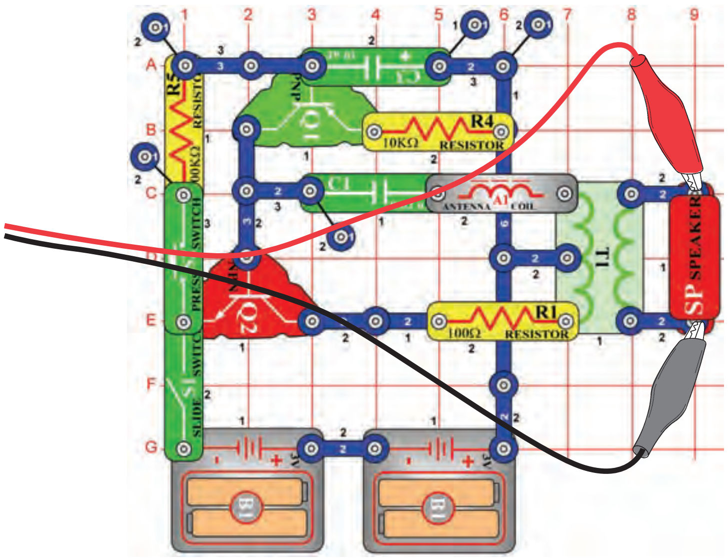
Electronic Sound PC (II)

Replace the 100KΩ resistor R5 with the 10KΩ resistor R4, place the 0.1μF capacitor back in the circuit as before. Now you change the frequency by changing the resistance in the oscillator.

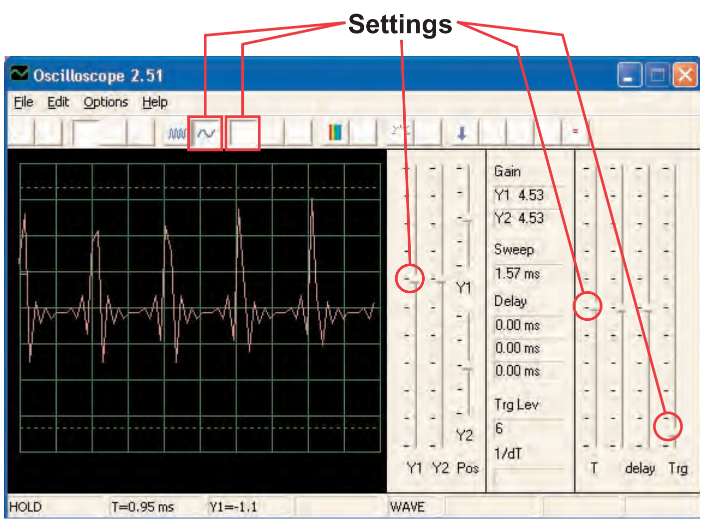
Project #PC65

Siren PC

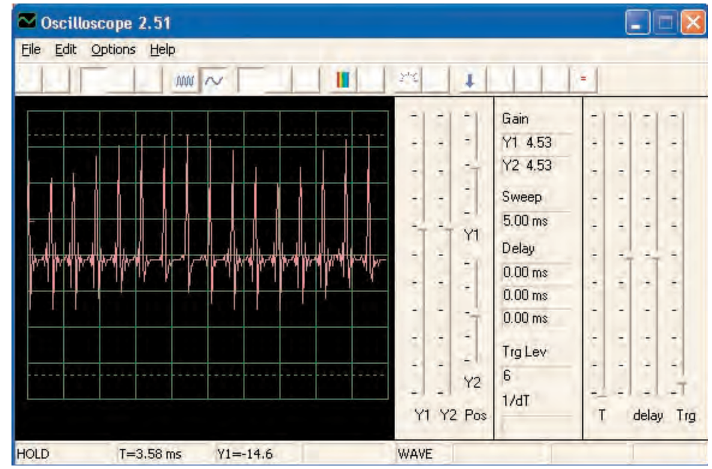
OBJECTIVE: To view the output of a fading siren circuit.



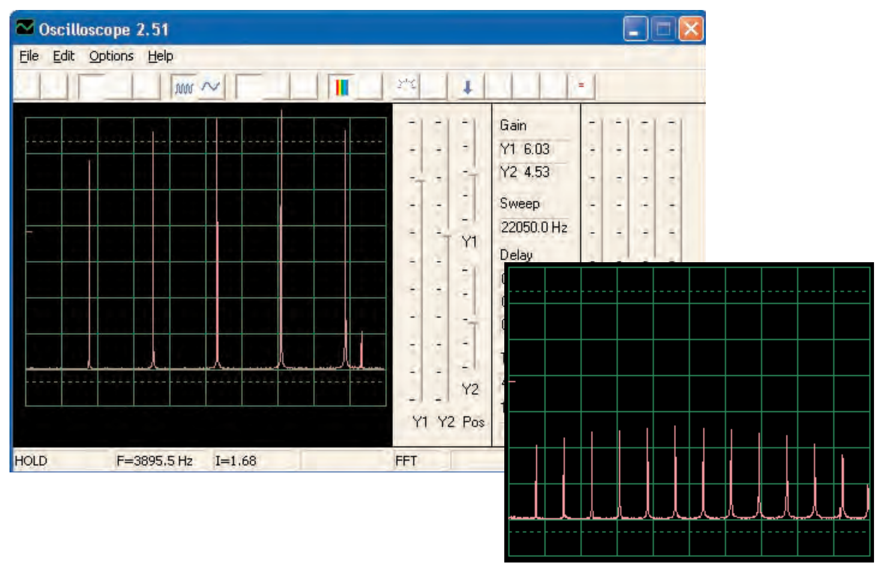
Build the circuit and try the **settings** shown. Flip on the slide switch and press the press switch for a few seconds and release. View the waveform as a siren starts up and then slowly fades away.



Note: Although the amplitude of the pulses appears to be varying across the screen (the wider time scale shown below shows this better), this is an illusion caused by the way Winscope measures the signal. The amplitude of the pulses is not really varying.



Winscope makes measurements using a 44kHz sampling rate, which is fast enough to measure the frequency of this signal (varying from 1-5kHz). However these pulses have much of their energy spread among higher frequencies that approach the sampling rate (see the sample spectrum plots at right), where the amplitude measurement becomes increasingly inaccurate.

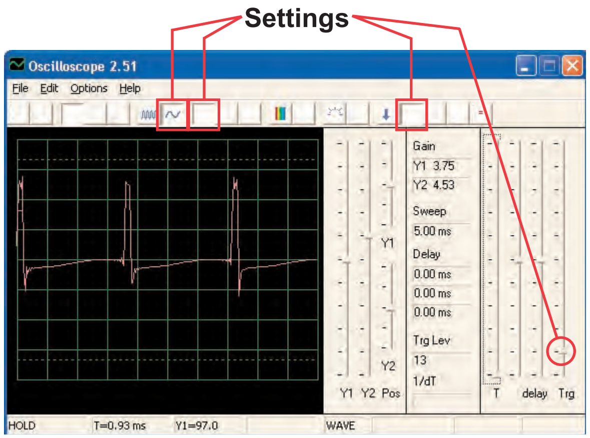


☐ Project #PC66

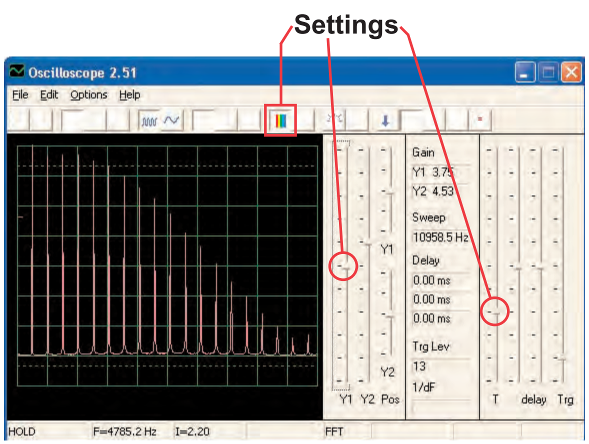
Drawing Resistors PC

OBJECTIVE: To draw your own resistors.

Use the circuit from the Drawing Resistors project #516, but connect the PC-interface cable across the speaker. Use a pencil to draw the shapes shown in projects #516-518, as per the directions given in those projects. Use Winscope to see how the waveforms and frequency spectrums vary as you move the jumper wires across the shapes to change the sounds. A sample is shown here.



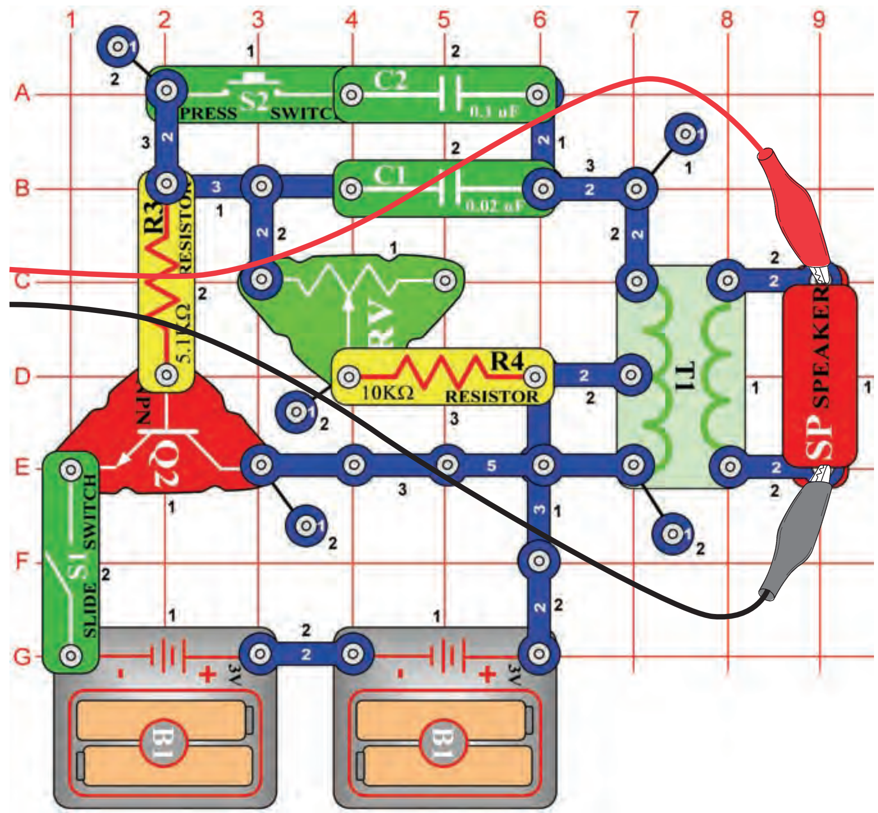
Next, place the loose ends of the jumper wires into a cup of water, as per project #519. The waveforms and frequency spectrum you see will be similar to the resistors you drew, just as the sounds are similar.



☐ Project #PC67

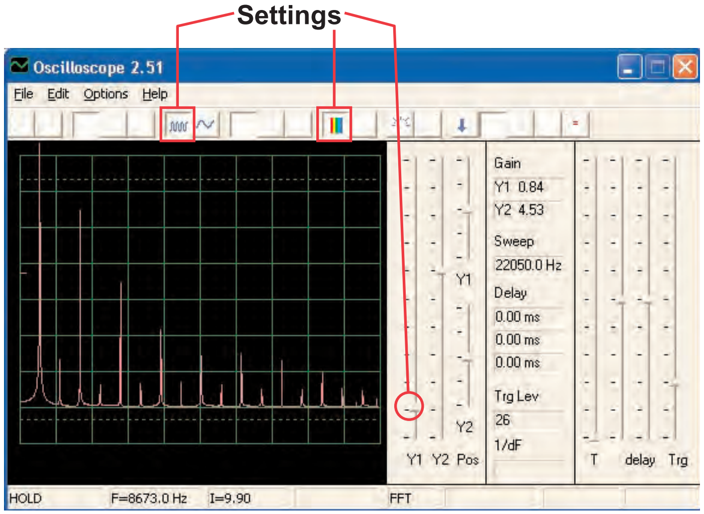
Electronic Noisemaker PC

OBJECTIVE: To view the output of an oscillator circuit.

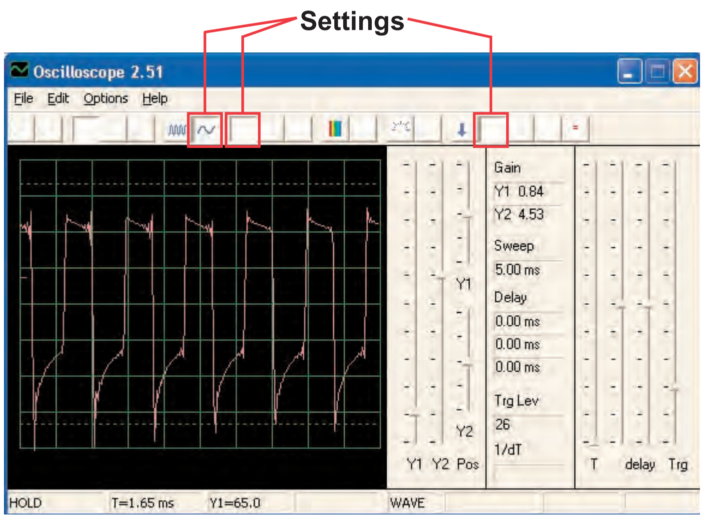


Build the circuit and try the settings shown. Flip on the slide switch and press the press switch a few times while moving the adjustable resistor control around. View the waveform and frequency spectrum.

Sample frequency spectrum:



Sample waveform:



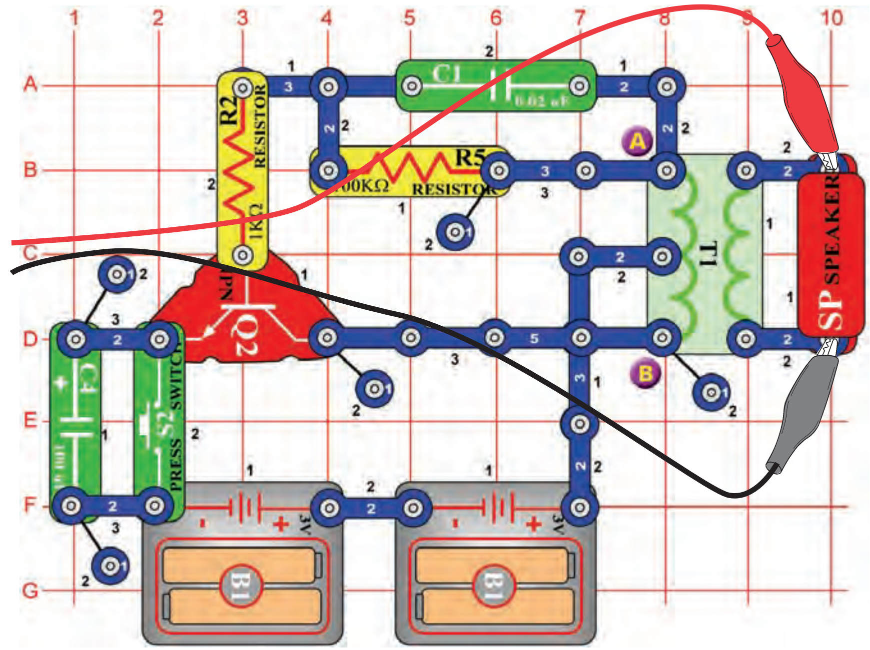
You can replace the 0.1µF capacitor C2 with the 10µF capacitor C3 (“+” on the right) to change the sound.

☐ Project #PC68 Electronic Noisemaker PC (II)

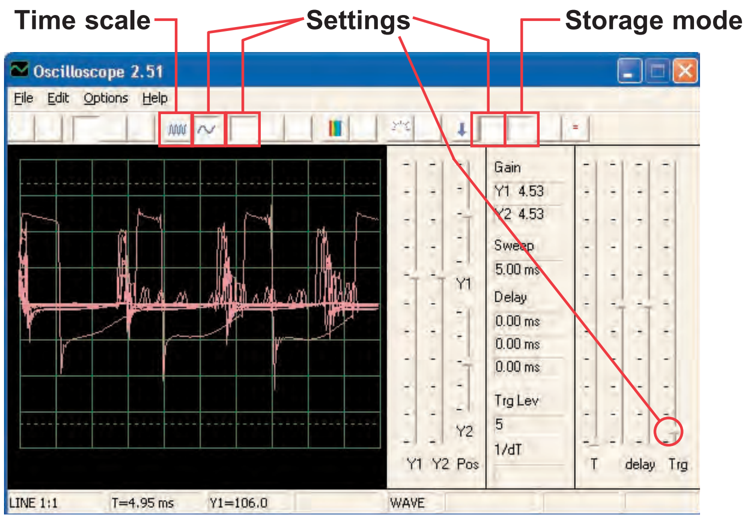
Replace the 10KΩ resistor R4 with the 100KΩ resistor R5. Now you change the frequency by changing the resistance in the oscillator.

☐ Project #PC69
Bee PC

***OBJECTIVE:** To view the output of an oscillator circuit.*



Build the circuit and press the press switch a few times, you hear cute sounds like a bumble bee. Use Winscope to see how the waveform fades away after you release the switch, and try **storage mode** as shown here.



You may replace the 0.02μF capacitor C1 with 0.1μF capacitor C2 or 10μF capacitor C3 (“+” on the right) to change the sound, but you may want to change the **time scale**.
You may also replace the 100μF capacitor C4 with the 10μF capacitor C3 or the 470μF capacitor C5 to change the duration of the sound.

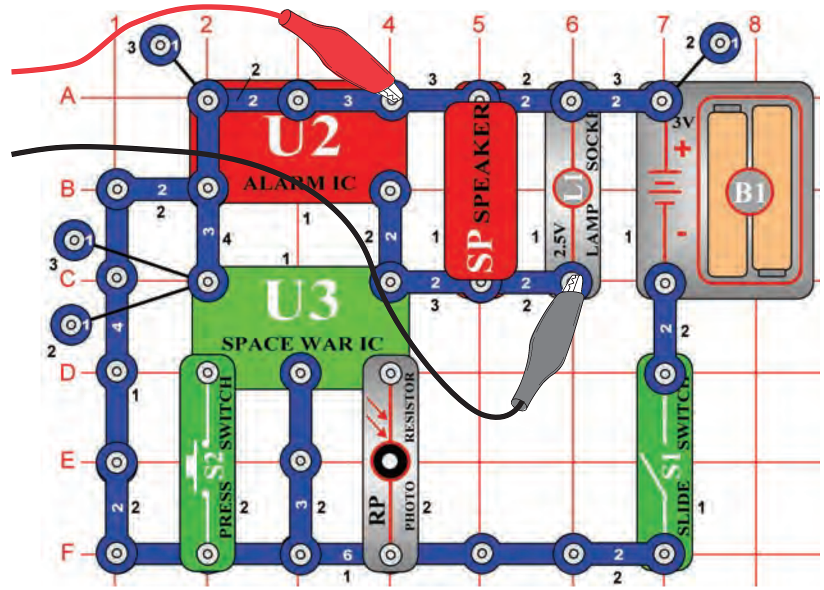
Project #PC70 Bee PC (II)

Remove the speaker from the circuit and place the whistle chip (WC) across the transformer at points labeled A & B on the circuit layout, connect the PC-interface cable across the whistle chip. Listen to the sounds and view the waveforms as you press the press switch. Replace the 0.02μF capacitor C1 with 0.1μF capacitor C2 or 10μF capacitor C3 (“+” on the right) to change the sound, or replace the 100μF capacitor C4 with the 10μF capacitor C3 (“+” on the right) or the 470μF capacitor C5 to change the duration.

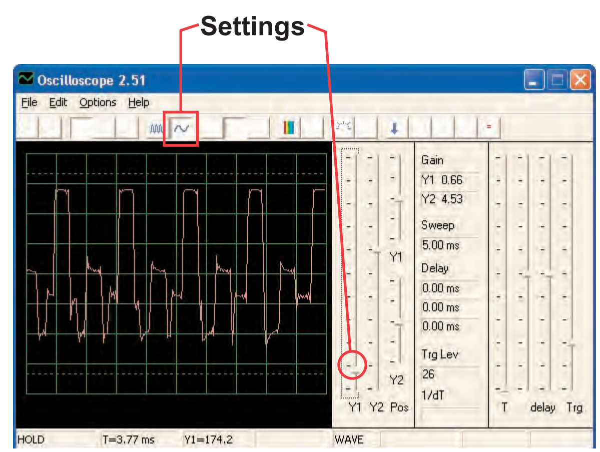
Project #PC71

Space War Alarm Combo PC

OBJECTIVE: To view the output of the combined outputs from the space war and alarm integrated circuits.



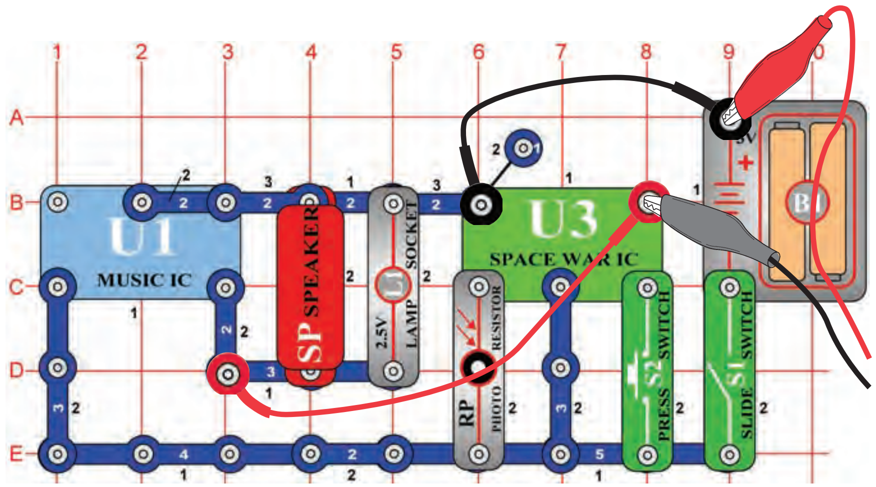
Build the circuit and try the settings shown. Turn it on, press the press switch (S2) several times, and wave your hand over the photoresistor (RP) to view all the sound combinations. You may also use FFT mode to view the frequency spectrum.



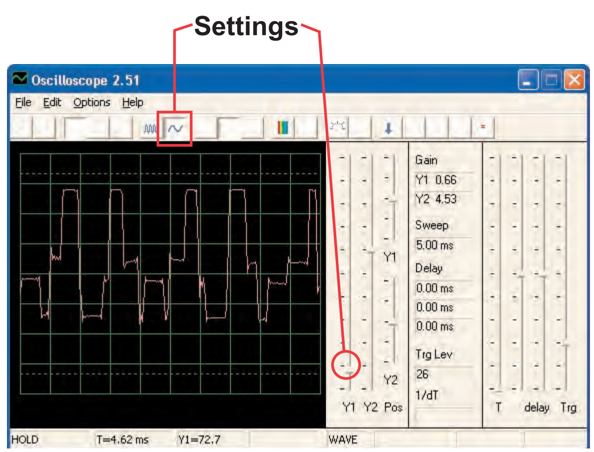
☐ Project #PC72

Space War Music Combo PC

***OBJECTIVE:** To view the output of the combined outputs from the space war and music integrated circuits.*



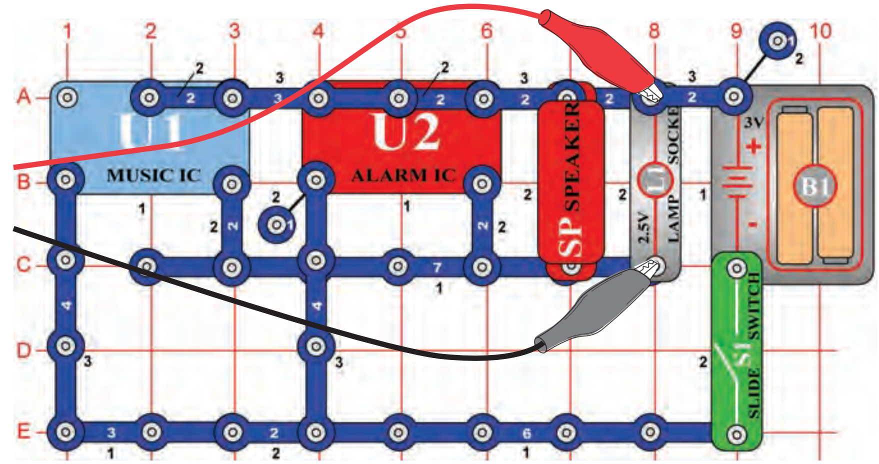
Build the circuit and try the **settings** shown. Turn it on, press the press switch (S2) several times, and wave your hand over the photoresistor (RP) to view all the sound combinations. Compare the waveform and spectrum to the alarm IC combo circuit.



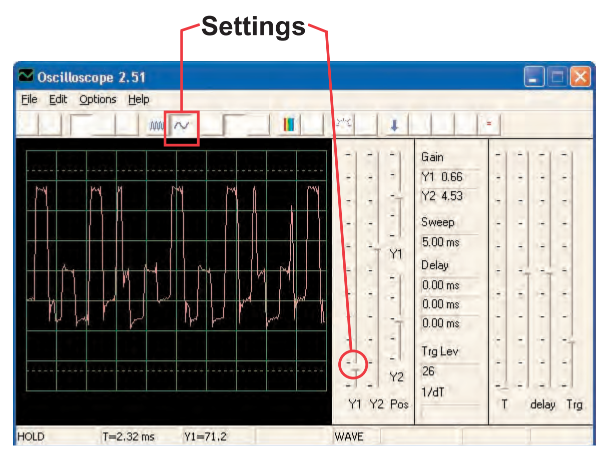
☐ Project #PC73

Sound Mixer PC

***OBJECTIVE:** To view the output of the music and alarm integrated circuits.*



Build the circuit and try the **settings** shown. Turn it on and view the waveforms.



IMPORTANT NOTICE

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